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CONTENTS

	Page
Science Teachers in Schools	177
Sir Hans Sloane and the British Museum. By Prof. Charles Singer	179
Chemistry of Styrene. By Prof. H. W. Melville, F.R.S.	180
Central American Orchids. By V. S. Summerhayes	181
The Universe and its Beginning. By Prof. H. S. W. Massey, F.R.S.	181
Electron Optics: Pure and Applied. By Dr. L. Jacob	182
Electron Microscopic Observations on Bacterial Nuclei. By Dr. J. R. G. Bradfield	184
Fisheries Survey of the Mauritius-Seychelles Area. By Dr. G. A. Steven	186
The Hoxne Interglacial Reconsidered. By R. G. West	187
Obituaries:	
Prof. Norman M. Comber. By J. S. Willcox	189
Prof. J. O. Wilhelm, O.B.E. By Dr. W. J. Mackey	189
Mrs. E. M. Reid. By W. N. Edwards	190
Dr. G. H. H. Tate. By Dr. T. C. S. Morrison-Scott	190
News and Views	191
Shortage of Graduate Teachers of Science	196
North of England Education Conference	197
Agricultural Crops: Quality versus Quantity. By Dr. G. D. H. Bell	198
Analogue and Digital Computers: Proceedings of the Western Computer Conference	200
Meteorological Office: Annual Report for 1952–53	200
Forest Products Research Laboratory, Princes Risborough: Report for 1952. By Prof. E. P. Stebbing	201
Ovulation and Pregnancy Corpora Lutea in the Ovaries of the Humpback Whale. By J. P. Robins	201
Structure of Cell Wall of *Valonia*. By Prof. R. D. Preston and Prof. W. T. Astbury, F.R.S.; Prof. F. C. Steward and Prof. K. Mühlethaler	203
Zone Electrophoresis of Muscle Extracts: Separation of Phosphocreatine, Creatine, Beta-Alanine Peptides, and Nucleotides. By Dr. Albert Wollenberger	205
Letters to the Editors:	
Internal Structure in Virus Particles.—Councilman Morgan, Solon A. Ellison, Harry M. Rose and Dr. Dan H. Moore	208
A Method for the Rapid Differentiation of Certain Non-pathogenic, Asporogenous Bacilli.—Dr. J. M. Shewan, W. Hodgkiss and J. Liston	208
Effect of Experimental Tuberculosis on the Distribution of Alkaline Phosphatase in the Adrenal Cortex of the Guinea Pig.—Dr. Amiya B. Kar	210
Choline Deficiency in the Guinea Pig.—W. G. Bruce Casselman and G. R. Williams	210
Steroid Requirements of Housefly Larvæ.—Dr. Ernst D. Bergmann and Zvi H. Levinson	211
Synthesis of Ribose in Animal Tissues.—Mary G. McGeown and Dr. F. H. Malpress	212
Prosthetic Group of Cytochrome a_3.—J. Barrett and Dr. R. Lemberg, F.R.S.	213
Cysteine and Phosphoserine containing Peptide Sequences of Ovalbumin.—Dr. Martin Flavin	214
Coproporphyrin Formation in Yeast.—Dr. J. E. Kench	214
Human Visual Purple and Absolute Threshold.—Dr. M. H. Pirenne	215
Occurrence of Dieldrin-resistance in Wild *Musca domestica* L. in England.—K. F. Goodwin-Bailey and M. Davies	216
Thermo-chemical Seed Treatment.—I. A. M. Cruickshank	217
An Antagonist of the Sterility Hormone Rutin in the Green Alga *Chlamydomonas eugametos*: Ombuoside = 7.4′-Dimethylrutin.—Dr. Franz Moewus and Dr. Venancio Deulofeu	218
Distribution of Radio-Frequency Brightness across the Solar Disk and the Derivation of a Model Corona.—P. A. O'Brien and C. J. Bell	219
Television Pick-up Tube for both Light and X-Ray Pictures.—L. Heijne, P. Schagen and H. Bruining	220
A Phase-Contrast Searcher for the Burch Reflecting Microscope.—R. J. King	220
Crystal Structure of Glycyl-L-Alanine Hydrobromide.—T. C. Tranter	221
Formulation of the Rate Equation in Chemical Kinetics.—P. V. Danckwerts	222
A Competitive Method of determining Association Constants.—R. Foster	222
Recent Scientific and Technical Books	Supp. viii

SCIENCE TEACHERS IN SCHOOLS

THE difficulties which many schools in Great Britain are experiencing in obtaining adequate staff for the science side are now becoming widely known. Reference has been made to this topic in these columns on many occasions during the past twelve months, and some general considerations on the implications of the shortage formed the subject of an article in *Nature* of December 19. The latest discussion on the subject was one arranged by the Federation of British Industries (see p. 196).

Just over a year ago, the actual staffing position in the schools was discussed (*Nature*, December 27, 1952), particularly as it affected the public and grammar schools. At that time there were about two hundred science posts unfilled; the close balance between supply and demand led to frequent staff changes and so there was little continuity of science teaching; the quality of both the academic and teaching ability of science teachers appeared to be lower than it was before the Second World War, and since 1950 the position was getting worse rather than better. This shortage in number and quality was ascribed to two main causes: there were not enough scientists to meet the post-war demands of industry, the Scientific Civil Service, the universities and the teaching profession; the pay of science teachers and their conditions of service compared unfavourably both with what they enjoyed before the War and with what they could now get in the other occupations open to them.

Since then, the Science Masters' Association and the Association of Women Science Teachers, and very recently the National Advisory Council for the Supply and Training of Teachers*, have issued reports on the problem. The National Advisory Council bases its conclusions on statistics obtained by the Ministry of Education and gives the administrative point of view; the teachers' associations describe the situation in the schools and reflect the front-line point of view; so the two reports are complementary.

The Council's report embraces not only public and grammar schools, but also technical and secondary modern schools and establishments of further education. It estimates that, between 1950 and 1955, 570 new science teachers will be available each year to meet an annual demand of 580 teachers. The post-war increase in birth-rate will increase the number of children in the grammar, technical and secondary modern schools from 2,000,000 in 1950 to 2,700,000 in 1960, and so the annual demand for science teachers during 1955–60 will rise to 1,020, if 1950 staffing standards are to be maintained. The Council notes that there is at present a shortage of science teachers, and that the quality of degree of the present science teachers is below its pre-war standard. It adds that the shortage will be very serious between 1955 and 1960 unless the supply of science teachers can be about doubled, by 1955. The

* Ministry of Education. Graduate Teachers of Mathematics and Science: a Report of the National Advisory Council on the Training and Supply of Teachers. Pp. iv+12. (London: H.M. Stationery Office, 1953.) 6*d*. net.

annual demand will fall to 380 in 1960, because the number of children in the schools will quickly decrease to its present number of 2,000,000 again. Hence, if the science teaching staff be doubled, in 1960 a number of teachers will become available for new vacancies. The Council concludes, therefore, that the serious problem is a short-term one and will be ended by about 1960, if the 1955–60 needs are met. It traces the present shortage of science teachers to three causes: the universities are not producing enough science graduates to satisfy the demands of industry, research in the universities, the Scientific Civil Service, and teaching; the pay of science teachers is inadequate; and the equipment of school laboratories and the supply of laboratory assistants are inadequate. The Council concludes by stressing that the shortage of school science teachers is not only a matter of serious concern to the schools but also to the whole nation. If it is not remedied, it will in due course decrease the number and quality of science students entering the universities, which, in turn, means that the output from the universities will fall at a time when it is essential that it should rise, to maintain and improve the standard of life in Britain. If the schools are starved of science teachers, this better supply of scientists will not be forthcoming, and the standard of life will go down at a steadily increasing rate.

The Science Masters' Association survey supports the facts in the National Advisory Council's report, and underlines the urgency of the position and the need for prompt action to remedy it. The Survey states that 115 science posts are vacant; as replies came from just over half the schools, there are probably two hundred vacant posts altogether. In eighty-four schools the teaching of one of the science subjects, physics, chemistry or biology, has been discontinued; in 1950 a report by the Incorporated Association of Headmasters noted that forty-eight schools had discontinued a subject. Both the academic and teaching ability of new science teachers is reported to be lower than it was before the War. Ten per cent of the science teachers are either non-graduates or arts graduates. Because the balance between supply and demand is so even, there is a constant movement of science staff, thus destroying the continuity of teaching in any one school. There would be many more vacant posts but for the existence of makeshift arrangements such as teachers continuing after the age of sixty-five, part-time teachers over sixty-five, part-time married women, two schools sharing the same teacher for a sixth-form science subject, and headmasters doing almost as much teaching as an assistant master. Finally, in the past ten years, 975 science teachers have left the schools either for industry or administration. The position in girls' schools is even worse than in boys' schools. Last autumn a survey by the Association of Headmistresses confirmed these facts.

The consequences of the shortage of school science teachers are now beginning to be felt. There are reports that places in university engineering schools and in hospital medical schools were unfilled at the start of the present academic year; science examiners marking Advanced Level papers for the General Certificate of Education state that many candidates know the subject by heart without understanding it; and the quality of assistant experimental officers in the Scientific Civil Service, who are of the same standard, recruited by the Ministry of Supply is declining.

The National Advisory Council makes four main recommendations for remedying the shortage of science teachers. As the problem arises because there are not enough scientists to go round, the Council asks for a conference at the highest government level to discuss ways of securing a more equitable distribution of the available scientists among the various occupations needing them. The Council then states that pay is a major factor in the situation, but feels it cannot properly pursue this further as the pay of teachers is settled by another statutory body, the Burnham Committee. It also suggests that the output of science specialists leaving the schools for the universities could be increased with the present strength of science staff, as there are still a number of science sixth forms which could be doubled in size without overburdening the teachers. Finally, it suggests that the 'glamour' of research should be counteracted by putting the case for teaching as a satisfying career to undergraduates in the pure science departments of the universities.

The National Advisory Council is to be congratulated on its objective and restrained presentation of the situation, the seriousness of which for the whole nation it has correctly appraised. Its first remedy should be implemented without delay; it has said all it properly can about pay, but it is significant that the new salary scales which the Burnham Committee has recommended to the Minister of Education for adoption from April 1, 1954, have been rejected by the associations representing the headmasters and assistant masters of grammar schools. But is the Council right in thinking that the supply of science undergraduates can be increased with the present science teacher strength? The Science Masters' Association report shows that there are about twice as many boys in science sixth forms as there were before the War, while it is likely that the number of science teachers has only increased by ten per cent in the same time. There are still many small science sixth forms in spite of the fact that the schools have made known to their pupils the great demand for scientists. Are not these small science sixth forms due partly to the fact that some of the science teachers are of such moderate ability and personality that they cannot attract any more pupils to their side of the school, and partly to the fact that, where the teacher is competent, he has already attracted all the pupils capable of doing sixth-form science? Finally, the Council has surely made a faulty diagnosis of the situation in judging it to be a short-term problem. On its own admission, it will only be a short-term problem provided the needs of 1955–60 are met, which means doubling the present supply of science teachers between 1955 and 1960. But the Council has no practical proposals for doubling the supply of science teachers by 1955 and

gives no evidence for believing that this can or will be done. If it is not done, the shortage in 1960 will be worse than it is now, because the number and quality of science graduates will have started seriously to decline; and the position will deteriorate at an increasing rate in schools, universities and industry.

It is difficult to resist the conclusion that the National Advisory Council is running away from the problem, the seriousness of which both for the schools and the nation it has so clearly stated. Why cannot the Council accept and act on the logical consequences of that statement? The shortage concerns the whole nation, because it threatens the supply of scientists and technologists essential to its well-being. The grammar schools in Britain are the main source of scientists and technologists. Surely, then, the development of secondary modern schools must take second place until the grammar schools have been made safe, so that they can satisfy the various demands for science graduates and ultimately the demand for them from the secondary modern schools themselves. At the moment, Great Britain is carrying an unprecedented load for defence in peace-time. While the resources available for education are severely limited, it is essential that the grammar schools, which are entrusted with the development of the talent of the ablest children in the country, should not be starved. They have already shown that they can carry out this task with some measure of success, and their products are in great demand for tasks of vital national importance. Their needs must be given priority in the educational system of Great Britain.

Once this decision has been taken, the way will then be clear for grappling with the problem of the present shortage in numbers and decline in quality of science teachers in the grammar schools. The solution of this problem will involve another difficult decision about the salary scales of all teachers in grammar schools. If these two issues are shirked, the Butler Act, which began by promising secondary education for all, may well in fact end by destroying the secondary education for the abler children which did exist before the War in the grammar schools of Britain. The first of these two issues lies within the province of the National Advisory Council, and it should give the Minister of Education unequivocal advice on the matter.

SIR HANS SLOANE AND THE BRITISH MUSEUM

Sir Hans Sloane and the British Museum

By G. R. de Beer. (Published for the Trustees of the British Museum.) Pp. 192+11 plates. (London: Oxford University Press, 1953.) 18*s*. net.

IT was unfortunate that the week of the Coronation of Her Majesty coincided with, and took attention from, the centenary of another event of national importance, namely, the foundation of the British Museum. That term rightly includes not only the vast collection at Bloomsbury but also the no less important Natural History collection at South Kensington. The British Museum was founded by Act of Parliament passed on June 7, 1753, as the direct result of the design of Sir Hans Sloane, who died a few months earlier in his tenth decade. He left his immense collections to the nation, desiring that they be used for public enjoyment and instruction and kept together "to the manifestation of the glory of God, the confutation of atheism and its consequences, the use and improvement of physic, and other arts and sciences, and the benefit of mankind". Parliament decided to combine with it two other considerable collections then available into one great national institution.

Of these collections, that of Sloane was by far the largest and most diverse. This fact and the action of the trustees named in his will, who brought the matter to the attention of Parliament, make this great physician the real founder of our national museum. Its two branches are rightly controlled by the same standing committee, thus emphasizing that any separation between the humanities and those other arts that we are accustomed to call the 'sciences' is but accidental, artificial and temporary, and that in many regions they do, in fact, overlap. This is wholly in accord with the feelings and outlook of the founder. The actual physical separation of the two types of objects was not effected for another century. It was in 1856 that the greatest of British comparative anatomists, Richard Owen (1804–92), was called as first director to South Kensington. It may well be that there is, for all institutions, an optimum size beyond which growth is harmful rather than helpful. Nevertheless, the separation of the 'sciences' from the 'arts' is a misfortune which Sloane himself foresaw and one which the present cordial relations of the two great branches of our national museum are now doing much to remedy.

Hans Sloane was born at Killyleagh, County Down, Ireland, in 1660. The name Hans—a shortened form of Johannes or John—implies no German relationship but was, it would appear, a Scottish–Irish form used at that time. He came of a fairly well-to-do family and seems never to have been in want. At nineteen years of age he came to study in London, and there he met and made friends with the illustrious naturalist, John Ray (1627–1705), and the equally illustrious chemist, Robert Boyle (1627–91). Both men influenced him deeply. After four years he left for further study in France, where he attended medical, botanical, chemical and anatomical lectures in Paris and Montpellier, but took his degree, for no very evident reason, at the obscure and now extinct University of Orange in Provence. He returned to London in 1684 and called on Thomas Sydenham (1624–89), the "English Hippocrates", with a letter from Boyle recommending him as skilled in scholarship, botany and anatomy. Sydenham read the letter, looked at the young man and said: "That is all mighty fine, but it won't do—Anatomy, Botany —Nonsense! Sir, I know an old woman in Covent Garden who understands botany better, and as for anatomy, my butcher can dissect a joint full as well; no, young man, all this is Stuff: you must go to the bedside; there alone you can learn disease".

Nevertheless, the two became fast friends. Sloane went to the bedside and became, beyond doubt, one of the most effective practitioners of his day, for,

despite the unscientific state of medicine, he was a very careful observer and had just that calm and cautious yet optimistic temperament that inspires hope and confidence in the patient. He disliked complex prescriptions, preferred to try one remedy at a time and was deeply aware of the influence of the mind on disease. In all circumstances and in any age he would have been a first-class physician.

All this is admirably told in this attractive little book by Dr. G. R. de Beer, the present director of the British Museum (Natural History). In 1687 Sloane sailed for the West Indies in the suite of the Duke of Albemarle, Governor of Jamaica. He spent some sixteen months in that island, and his report on its natural history is a classic. He returned to practise in London, occupying his spare time in accumulating, arranging and cataloguing his collections which, in course of time, became extensive. In 1695 he married and settled at 3 Bloomsbury Place, where he practised for many years. In 1712 he became physician to Queen Anne and in 1706 physician-general to the Army. In 1716 he was made a baronet, being the first medical man to receive that title. In 1719 he became president of the Royal College of Physicians, and in 1727, on the death of Newton, succeeded him as president of the Royal Society. Among his medical activities is his physiciancy of Christ's Hospital for thirty-six years, his assistance to Captain Coram (1668–1751) in instituting the Foundling Hospital in 1739, and his attempt to establish a free dispensary. He practised until he was eighty-two, when he retired to Chelsea, where he died and was buried eleven years later.

The number and variety of the collections accumulated by Sloane is truly astonishing. There were about 50,000 printed books that formed the basis of the British Museum Library, about 3,800 volumes of manuscripts, about 32,000 medals and coins, 334 volumes of dried plants which formed the basis of the British Museum Herbarium, 12,500 other specimens of plants, 5,500 insects, 1,900 quadrupeds, 1,500 fishes, 1,200 birds, and thousands of other specimens under other headings. Some idea of the variety of the collection can be gathered from a special issue of the *British Museum Quarterly* that appeared last June as a special bicentenary number. In the articles by keepers of various departments, under the general charge of the director and principal librarian, Sir Thomas Kendrick, details may be learned of the nature of the treasures in their keeping.

We cannot end without an anecdote of Sloane which may not be known to all readers of *Nature*. In 1740 the composer Handel was taking tea with Sloane, who showed him his library. Handel placed his buttered muffin on the volume in his hand. The outraged silence of Sir Hans failed to appal him with a sense of guilt. "To be sure," Handel admitted later, "it was a careless trick, but it did no monstrous mischief; yet it put the poor old bookworm terribly out of sorts. I offered my apologies but the old miser would not have done with it. Had it been a biscuit, it would not have mattered." And Handel went on to suggest that Sloane's displeasure was due to his parsimoniousness. "But muffin and butter. And I said to myself, 'Ach, mein Gott, that is the rub! It is the butter'"; which, of course, it was, but not for the reason which Handel alleged. In those days butter was not rationed—except in libraries.

Charles Singer

CHEMISTRY OF STYRENE

Styrene

Its Polymers, Copolymers and Derivatives. Edited by Ray H. Boundy, Raymond F. Boyer and Sylvia M. Stoesser. (American Chemical Society Monograph Series, No. 115.) Pp. xxii+1304. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1952.) 160s. net.

THIS impressive volume is the complete guide to the chemistry of styrene, its polymers, copolymers (excluding synthetic rubber) and their derivatives. The extensive study of styrene and its polymers has had a profound effect in high-polymer chemistry as a whole, and therefore the book is of very much wider interest than its title would imply. Since it deals with every aspect of the subject from the purely academic to highly specialized technology, it has to be a composite work from a number of pens. Its editors, R. H. Boundy, R. F. Boyer and S. M. Stoesser, who have themselves contributed extensively to the subject, have welded the separate articles into a coherent whole so effectively as to avoid undue overlap. With one or two exceptions the authors are members of the Dow Chemical Co., which pioneered much of the earlier work on styrene. The book, therefore, is authoritative, both on the academic and technological aspects. Besides being encyclopædic in its contents, each contribution is a critical discussion of the topic under review. Furthermore, the wider implications of the discussion to other branches of polymer chemistry are not neglected, even though the main theme—styrene—is kept in mind. The compilation of a text of this magnitude, even with the best co-operation, occupies a considerable amount of time; but in spite of this difficulty each chapter is surprisingly up to date. In a series of appendixes to several of the chapters, more recent work up to 1951 is briefly reviewed and appropriate references quoted.

It is impossible in this brief review to do full justice to the wealth of material: it is only practicable to say something of the general arrangement and special features of the volume. The arrangement is strictly logical: the preparation and properties of styrene; polymerization methods; and the nature of the properties of the polymer, copolymers and derivatives of styrene. Although much of styrene goes into butadiene–styrene copolymers, synthetic rubber receives only a very limited treatment. Had this topic been discussed at all comprehensively, the book would have had to be doubled in size, and in any event synthetic rubber is best dealt with in a separate volume altogether.

The historical introductory chapter, when read with present-day insight, shows how much excellent knowledge there was about styrene before the intensive developments of the past fifteen years. The manufacture of styrene via ethylene and benzene is the only commercially important method, and this is dealt with in detail. Then follow particularly useful chapters thoroughly surveying the chemical and physical properties, analysis and handling of the monomer. The chapter on the polymerization of styrene is an essay in addition-polymerization in so far as the principles of the subject are concerned. Similarly, the chapter on the molecular weight of the polymer again outlines much that is of general interest in the treatment of the polymer as a high-polymer substance. No less complete are the chapters dealing with the mechanical, optical and electrical

properties of the polymer. Degradation of the polymer by all the usual agents is also treated separately. Logically, there follows a much shorter chapter concerned with the chemical modifications of the polymer. Next, the derivatives of styrene and α-methyl styrene are adequately considered, as well as the use of styrene in the production of resins of which it forms one component. The latter chapter is concerned much more with the practical affairs, and the theory is considered quite separately in a chapter on copolymerization. Since much of the work described in this volume has been done on the western side of the Atlantic, the editors have wisely introduced a chapter dealing with the German developments prior to, and during, the Second World War, which makes a very interesting comparison in the methods of approach used to solve these problems in two parts of the world.

Not content with covering the whole subject in this way, the editors arranged for a complete set of patents to form part of the book. This means that, if anything was omitted in the ordinary discussion, it is included in the considerable volume of references. A large section is devoted to the problems involved in the manipulation of the polymer as a plastic in all its variety of rules, the moulding and fabrication of sheet, and even of filaments. Although some of these processes are necessarily based on empirical knowledge, the authors of the chapters as far as possible have described fundamental principles, so that again these chapters have general interest for many other polymers with similar kinds of properties.

In short, this is a volume that anyone must possess who has to deal in any respect with styrene and its polymers. There is, too, a fund of knowledge of great interest to anyone dealing with synthetic polymers as a whole. It contains the story of an outstanding industrial achievement to a considerable extent spurred on, but not initiated, by war-time necessity.

H. W. MELVILLE

CENTRAL AMERICAN ORCHIDS

Orchids of Guatemala

By Oakes Ames and Donovan Stewart Correll. (Fieldiana: Botany. Vol. 26, No. 2.) Pp. iv+399–728. (Chicago: Chicago Natural History Museum, 1953.) 5 dollars, cloth bound; 4 dollars, paper bound.

CENTRAL AMERICA is well known as one of the richest two regions in the world for orchids, the other being New Guinea. Costa Rica, with an area about equal to that of Wales and an orchid flora consisting of about nine hundred species, is probably richer in orchids than any other comparable area; nevertheless, Guatemala, which contains more than five hundred species, may rightly lay claim to a very extensive orchid flora.

Accounts of the orchids of Costa Rica and Mexico have already been published, but in neither case in such detail nor in such an attractive manner as in the "Orchids of Guatemala". Indeed, Dr. Correll, following the death of his co-author, Prof. Ames, has produced a book which is a model of its kind, beautifully produced and printed.

Owing to the complexities of the floral structure of orchids, good illustrations are essential for their proper understanding, and these are provided on a scale seldom seen in an account of this kind. The whole book, of which this is the concluding part, contains nearly two hundred delightful line-drawings, including illustrations of all the genera described and of many additional species. These supplement the excellent generic and specific descriptions and the workman-like keys for the determination of the various groups. Dr. Correll, following the views of his mentor, Prof. Ames, takes a rather conservative view of species in the reviewer's opinion; but that is, of course, a matter on which no two specialists will entirely agree.

Altogether, this is a book which no student of the orchids should be without and which, indeed, could well be studied with profit by workers on other groups of plants.

V. S. SUMMERHAYES

THE UNIVERSE AND ITS BEGINNING

The Creation of the Universe

By Prof. George Gamow. Pp. xii+147+12 plates. (New York: Viking Press; London: Macmillan and Co., Ltd., 1952.) 21*s*. net.

THE study of cosmogony occupies a peculiar position among scientific activities. From long experience it has become quite clear that, unless there are continuous and manifold checks applied to theoretical speculation, its relation to experience becomes extremely slender. The chance that pure theory, even when it has at its disposal the great volume of present-day knowledge of physics, could succeed in describing such ultimate phenomena as those concerned with the development of the universe from some elemental beginning is very small indeed. The observed data which bear on these questions are still wholly insufficient to provide a really adequate check on any hypothesis. On the other hand, it is obviously necessary in formulating any cosmological picture that it should be consistent with modern physical principles and knowledge as well as with the meagre observational data which bear directly or indirectly on the matter.

Despite the vanishingly small chance of hitting upon the actual way in which the past history of the universe has developed, the intellectual exercise involved in formulating a cosmogony consistent with the foregoing requirements is of absorbing interest. No more entertaining exponent of a scheme of this kind could be found than Prof. George Gamow, whose popularization of some of the more recondite principles of physics through the dreams of "Mr. Tompkins" are deservedly famous.

The account he gives of the development of the universe makes absorbing reading. The expert use of the most recent discoveries in nuclear physics also makes it very instructive as long as one retains due scepticism about the ultimate reality of the scheme proposed. Even the dullest of readers must be impressed by diagrams purporting to give, for example, the "Chemical changes in the universe during its first half-hour". The sheer impudence of it is breathtaking.

In the first part of the book Prof. Gamow discusses the case for a dynamic rather than static picture of the universe. He describes the evidence about the age of different parts of the universe. This evidence indicates that all parts are of about the same age—a few thousand million years—and he considers that this strongly supports the evolutionary picture.

The evolutionary picture which is proposed is based on the observational fact that the universe is

expanding. Assuming the rate of expansion to have been the same in the past, the present universe must have expanded from a state, which would have had the density of nuclear matter, about $1{\cdot}7 \times 10^9$ years ago. It is this state, called the ylem, which is regarded as the primitive condition from which the universe is developed. The ylem is regarded as a nuclear gas at a temperature of many thousands of millions of degrees. In this gas protons, neutrons and electrons co-existed in a dynamical equilibrium. As the gas expanded, it cooled and nuclear synthesis began. The author claims that, by discussing the dynamics of the nuclear reactions involved, it is possible to understand the abundance distribution of the elements, which is significantly similar throughout the universe.

Having described the first hour of the embryonic universe, Prof. Gamow then considers the processes which led, through the course of a few hundred million years, to the structure of the present universe with its stars and galaxies. In the course of this he discusses many aspects of astrophysics, such as the sources of nuclear energy in the stars, which are quite well established and of great interest.

The whole book is written in a most pleasant style, and it presents a coherent argument throughout. For the professional physicist and astronomer it is well worth reading for the excellent way in which new ideas are presented and the outlook of modern physics employed. For the student or the layman it should make fascinating reading, as it is in no sense technical and has the largest possible horizon.

H. S. W. Massey

ELECTRON OPTICS: PURE AND APPLIED

Electron Optics

By Prof. O. Klemperer. (Cambridge Monographs on Physics.) Second edition. Pp. xiii+471. (Cambridge: At the University Press, 1953.) 50*s*. net.

In describing this book one cannot help recalling the well-known lines about books written by Bacon in his "Of Studies": "Some books are to be tasted, others to be swallowed and some few to be chewed and digested". Bacon would no doubt have agreed that all three categories could have been accommodated in the one book under review here, for it caters for three separate types of reader—physicists working in fields other than electron optics, those engaged in electron optical design, and those actively engaged in this research field and pondering over its problems.

Before discussing how the book meets these needs, it is as well to trace its origin and purpose. The monograph on "Electron Optics" appeared as a Cambridge Physical Tract in 1939. At that time the subject as such had been recognized as a new and developing branch of 'electron physics' for about a decade, and its general basic principles had been formulated. These had been stated with conciseness and clarity in the first edition; so much so, in fact, that it formed an excellent introduction to the subject for all those engaged in research and development work involving the principles of operation and design of electron devices of many kinds. Since that time the importance of the subject has been widely recognized in both academic and industrial fields, and a considerable volume of work has appeared, enlarging upon and extending the field of application. The extent of this development can be gauged by a comparison between the first and the present second edition, in which the book has expanded to approximately six times its original size and includes some five hundred references to original papers.

The task of co-ordinating so extensive a field is no easy one. It requires a great deal of selective judgment and critical ability on the part of an author, as well as an exceedingly wide acquaintance with fundamental work in borderline fields; these are necessary in order to present the subject with coherence and unity. These qualifications are happily to be found in Prof. Klemperer, who has himself contributed a large amount of important work in the subject of which he writes.

While it can generally be said that the pattern of the subject-matter has now become formalized, yet the author introduces and develops many topics in an original way; in many instances there is evidence of an individualistic outlook which is highly stimulating to those actively engaged in research. The great merit of the book is that, as stated earlier, it can be used profitably by all types of worker. The novice will find a clear description of all the basic properties of focusing fields—electrostatic and electromagnetic—as well as their defects, treated mainly from the experimental point of view. The initiated will welcome good discussions on the effects of space charge on round and flat beams and fields, as well as a separate chapter under the heading of "Emission Systems" which deals adequately with the important characteristics of 'electron guns'. The chapter on emission systems with line focus brings to the reader's notice the characteristics of recent developments on 'box' and 'double lipped' lenses and their application to the design of X-ray tubes, triode and beam power valves and photomultipliers; while that on 'deflecting fields' will be of special interest to television engineers because of the detailed treatment of inherent errors and their correction.

The experimental physicist engaged on problems of 'separation analysis' will find much useful information on cylindrical and spherical condenser focusing systems, as well as on the properties of magnetic sector fields, and mass and beta-ray spectrometers (their dispersion and resolving power).

The final chapter, on applications in industry and research, is in a sense a consummation of all that has gone before, for it gives an account of the various fields in applied physics enriched by the application of knowledge of principles established earlier. Here are to be found clear descriptions of such important devices as television pick-up tubes, scintillation counters, image converters, electron microscopes, electron accelerators, storage tubes, etc.

On the whole, the book is authoritative and shows a good balance by skilful blending of the old and new. It gives a just emphasis to those topics which are in process of development, indicates and assesses the importance of complicating factors in interpreting fundamental results and will have the effect of stimulating the more advanced worker in his researches. It also carries much useful information in the form of curves, for the designer of systems who requires them to have a certain 'quality'. It has a good index and copious references to original sources. The latter could be improved in the bibliography by giving the page number in place of the chapter.

L. Jacob

Organic Chemistry

The Chemistry of the Compounds of Carbon. By Prof. Lucius Junius Desha. Second edition. Pp. xvi+595. (London: McGraw-Hill Publishing Co., Ltd., 1952.) 55*s*. 6*d*.

PROF. L. J. DESHA has written an introductory course for university students, including those not continuing the study of chemistry. His aim is not to make a review of the vast amount of factual matter, but rather to help students to acquire an understanding of fundamental principles so that they may look up facts with intelligence.

Accordingly, in place of the usual approach he selects topics which serve his purpose and arranges them in a sequence so that concepts and terminology are gradually introduced. Then, as each theoretical point, such as resonance or reaction mechanism, is met, Prof. Desha gives a clear, elementary and yet, for this stage, sufficiently full exposition of it. Again, in pursuance of his plan, aromatic compounds are presented to the reader in as early as the fifth of the twenty-seven chapters; thenceforward alkyl and aryl compounds are considered together. Petroleum and coal, as the chief modern sources of industrial products, fill the sixth chapter. Prof. Desha devotes three chapters to polyfunctional compounds, one to dyes and one to heterocyclic compounds. In Chapter 27, on organic chemistry and life, substances such as cortisone and penicillin are not merely mentioned but more than a page is given to each.

This is a brightly written book, effort-requiring yet socially and intellectually interesting. It is obviously the work of an experienced teacher. The new edition is thoroughly up to date and affords a sound introduction to organic chemistry for all kinds of students.

G. F.

Manures and Fertilisers

By Dr. A. M. Smith. (Nelson's Agriculture Series.) Pp. xii+276. (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1952.) 15*s*. net.

THE student who takes up this book as a guide to the study of manures and fertilizers will find himself in good hands. Dr. A. M. Smith, of the Edinburgh and East of Scotland College of Agriculture, is a teacher and advisory worker of long experience who has many valuable points of contact with the fertilizer industry and has closely observed the changes in fertilizer policy operating during and after the War. So far as the chapter headings are concerned, the book follows conventional lines: it starts out with the general principles of plant nutrition, follows with a discussion of the various bulky and concentrated organic manures, and then turns to the common nutrients and trace elements. The treatment of these topics is exceedingly good.

Dr. Smith wastes no words; in the compass of some two hundred and sixty pages he has brought together an impressive amount of information that is reliable and up to date. Particularly useful sections deal with composts, sewage sludge and town refuse, while the section on poultry manure contains information not easily obtainable in compact form elsewhere. In dealing with the fertilizer materials, a note is provided on the natural reserves of raw materials, and the reader obtains a clear outline of the manufacturing processes without becoming bogged down in technical detail. Sidelights are thrown on the fertilizer salts used in other countries—a useful point since British materials are comparatively few. The chapter on trace elements is well done and put in its proper perspective, and it is emphasized that the diagnosis and treatment of deficiencies is a specialist's job. The broad lines of fertilizer utilization on the various crops is the subject of a lengthy chapter.

Running through the book there is a streak of agricultural common sense which is not always apparent in publications of this kind.

Rockets, Missiles, and Space Travel

By Willy Ley. Pp. xii+436. (London: Chapman and Hall, Ltd., 1951.) 30*s*. net.

THIS is the second English edition of the author's book published in 1948 under the title "Rockets and Space Travel" (see *Nature*, **163**, 820; 1949). The new edition has been very largely rewritten and amplified; the ground covered remains essentially the same, but the material has been rearranged. The most important addition is an account of recent American developments in rocketry carried out in New Mexico at the White Sands Proving Ground—a site established in February 1948 for the testing of long-range rockets. The first projectiles fired here were German *V*2's, which were later followed by American missiles of a similar character such as the 'Aerobee' and 'Viking' rockets. Military rocket research in Great Britain, which dates from 1934 and was well under way in 1937, is described more fully than in the first edition. It is unfortunate, but unavoidable, that official reticence should have created the impression that British achievements in this field have been of minor importance. There are several appendixes containing a varied assortment of numerical and factual information on all aspects of rocket development and navigation. Finally, the valuable bibliography has been considerably extended.

R. A. RANKIN

Statistical Tables for Biological, Agricultural and Medical Research

By Sir Ronald A. Fisher and Dr. Frank Yates. Fourth edition, revised and enlarged. Pp. xi+126. (Edinburgh and London: Oliver and Boyd, Ltd., 1953.) 21*s*. net.

THIS standard work, first published in 1938, is indispensable for anyone seriously interested in statistics, and most such persons already possess one of the earlier editions and will want to know how much new matter now appears. The Roman numbering of the tables is retained with Arabic appendages for new tables. Since the first edition, Tables V, VIII, XI, XVII and XXIII have been improved, and ten new tables have been added. These deal with the significance of the difference between means when the variance cannot be pooled, with the fiducial limits in a binomial distribution, with bacterial counts estimated by dilution until there is none left, and with tests for periodic components. There are two new tables for geneticists, giving scores for linkage data from intercrosses, and segmental functions. There is also a table of the normal probability integral and two tables of random permutations.

The explanations and examples in the introduction are very valuable for beginners and generally adequate; but those dealing with Tables VIII 3 and XXIV might perhaps be amplified with advantage. The authors have done much not only for the professional statistician, but also for the weaker brethren, though they refuse to provide the simplified *t*-test based on ranges. It was clearly impossible to include everything.

J. H. GADDUM

ELECTRON MICROSCOPIC OBSERVATIONS ON BACTERIAL NUCLEI

By Dr. J. R. G. BRADFIELD
Cavendish Laboratory, Cambridge

WIDELY divergent views have been held regarding bacterial nuclei. Some investigators have denied their existence; others have gone to the opposite extreme and suggested that bacteria consist of naked nuclei. In fact, however, there has long been strong evidence (reviewed by Robinow, Bisset and Knaysi[1]) for the existence in bacteria of bodies equivalent in many respects to the nuclei of animal and plant cells. Apart from the size problem, the chief difficulty in the demonstration of bacterial nuclei by the light microscope has been the existence in the cytoplasm of these organisms of abundant ribonucleic acid, which often stains strongly with 'nuclear' stains, thus masking the nucleus itself, or else creating the impression that nuclear material is uniformly distributed throughout the bacteria. When the ribonucleic acid is removed by dilute acid, or by ribonuclease[2], nuclei can often be demonstrated. As regards work with the electron microscope, progress has been hindered by at least three factors: (*a*) absence of specific staining methods; (*b*) doubts as to whether bacterial nuclei might be expected to appear dark or light in electron micrographs; (*c*) the considerable opacity of whole unstained bacteria (especially cocci) to electrons, in the normal current working-range of 50–100 kV.

Techniques

These obstacles have been to some extent overcome by two recent developments: (*a*) thin sectioning; (*b*) a modified Feulgen stain suitable for use with the electron microscope. The sections described here were cut on a modified Cambridge rocking microtome at a thickness of approximately 0·035 μ from bacteria fixed in most cases in buffered osmium tetroxide solutions and embedded in poly-*n*-butyl methacrylate[3]. In the *normal* Feulgen technique, mild acid hydrolysis produces from deoxyribonucleic acid an insoluble aldehyde, which re-colours Schiff's reagent and takes up the purple dye so produced. This dye cannot, however, be detected in the electron microscope. Hence, in the *modified* Feulgen technique, details of which will be published elsewhere, the aldehydes produced by acid hydrolysis of deoxyribonucleic acid are allowed to reduce ammoniacal silver hydroxide, thus depositing metallic silver, which can easily be detected in the electron microscope. A similar technique has already been employed by Bretschneider[4], on the rather unrewarding heads of mammalian spermatozoa, the extremely dense Feulgen-positive contents of which still defy cytological analysis. Our procedure is rather simpler and based on experience in the use of ammoniacal silver for staining connective tissue. Our observations have so far been limited to two kinds of bacteria—the 'Oxford' staphylococcus from the National Collection of Type Cultures, and a paracolon bacillus (*Paracolobactrum* sp.) morphologically similar to, but slightly smaller than, *Escherichia coli*. In each case, organisms from old resting slopes were compared with actively growing organisms freshly suspended in a 'Difco' broth for four hours at 37° C.

Staphylococcus aureus

Intact staphylococci (Fig. 1) are extremely dense to 70 kV. electrons (even when formal-fixed and unshadowed) and little or no detail of their internal structure can be observed. In sections (Fig. 2), the actively growing coccus (average diameter 0·5 μ) shows a well-defined, spheroidal, central area (0·2 μ–0·25 μ in diameter), which in osmium-fixed cells is of markedly lower electron-scattering power than the periphery. This clearer central area contains bodies remarkably similar in form and arrangement to chromosomes (Fig. 2) and nucleoli (Fig. 3), though it would be rash to identify them as such without much further study.

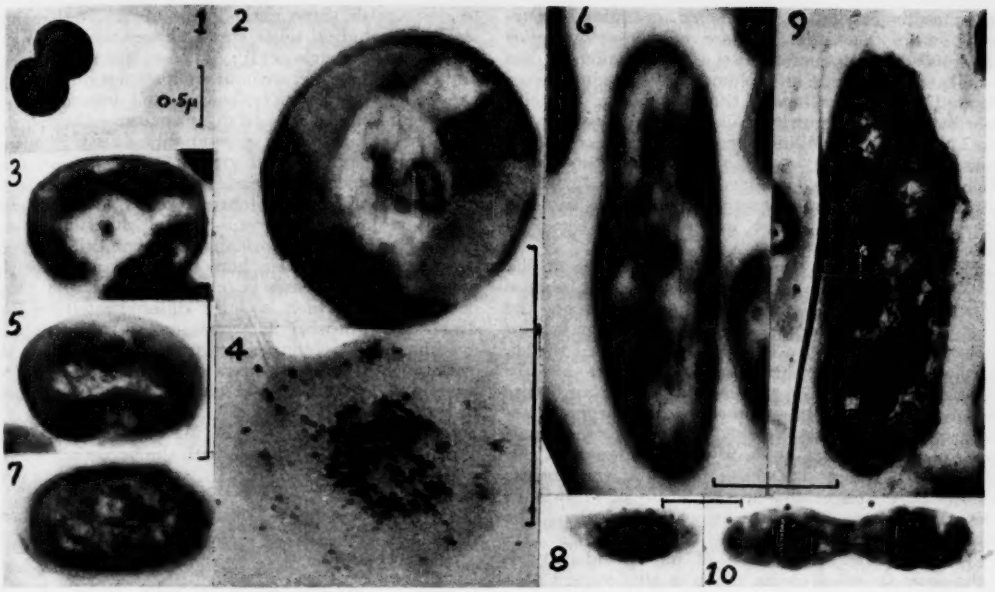
The modified Feulgen stain (Fig. 4) shows that most—probably all—the deoxyribonucleic acid is localized in these central bodies. The latter, therefore, have both the morphological and the chemical characteristics of animal and plant nuclei and may properly be called bacterial nuclei.

Several kinds of control are run for the modified Feulgen staining method, including the normal Feulgen control in which the preliminary acid hydrolysis is omitted. In general, such controls confirm the validity of the method, though further critical investigation along established lines[5] is needed. One difficulty which we hope to overcome is the random precipitation of silver granules during staining, common to most ammoniacal silver techniques; this probably accounts for the small deposits around the extreme periphery of the bacterium (Fig. 4), which was stained whole before sectioning. (It would certainly be unjustifiable at present to regard them as evidence of peripherally situated deoxyribonucleic acid.)

Although the boundaries of the nucleus are quite distinct, we have as yet seen nothing which could clearly be identified as a nuclear membrane. In a dividing staphylococcus the nucleus elongates, becoming dumb-bell-shaped, and nips into two. The two daughter cells often remain associated for some time in the familiar diplococcal stage, separated by a double cell-wall; but under our conditions of growth, four-cell aggregates do not occur. The relatively uniform distribution of chromatin throughout the dividing nucleus (Fig. 5) argues against the existence of true mitosis; but since it is by no means certain that there exists a full nuclear apparatus of chromosomes, nucleoli and nuclear membranes, it is premature to make detailed comparisons of division mechanisms.

Paracolon Bacillus

An actively growing paracolon bacillus, fixed in a buffered osmium tetroxide solution, possesses a large, irregular, ellipsoidal central region of low electron-scattering power (Figs. 6, 7). In a bacillus 2 μ long and 0·6 μ wide, this clearer central zone is about 1·5 μ long and 0·4 μ wide. The modified Feulgen stain (Fig. 8) shows that the deoxyribonucleic acid is localized in approximately the same region. This suggests that, as in the staphylococci, the central clearer region in the osmium-fixed organism is the nucleus.



(1) Whole staphylococci, shadowed 30° to horizontal. (2–5) Sections of actively growing staphylococci: (2) probably chromosomes in cell approaching division; (3) probably nucleolus; (4) modified Feulgen stain, the central cluster of silver granules indicating that the nucleus is rich in deoxyribonucleic acid; (5) dividing nucleus. (6) Longitudinal section, and (7) oblique transverse section, of actively growing paracolon bacilli. (9) Longitudinal section of old, resting bacillus. (8) and (10) Modified Feulgen stain showing (in whole bacilli) large nucleus in non-dividing cell (8) and smaller, more compact nuclei in two recently formed daughter cells (10). Magnification: each scale represents 0·5 μ

The nucleus of the bacillus is much larger (relatively and absolutely) than that of the coccus, the nucleocytoplasmic ratio being about 1 : 2 for the paracolon bacillus and 1 : 10 for the staphylococcus. Like those of the cocci, the nuclei of the bacilli appear to contain chromatin threads and nucleoli; but detailed interpretation is complicated by the existence of fingers of cytoplasm protruding into the nuclei, the latter being much less distinct and compact than in the cocci. This irregular form is greatly accentuated in older, resting bacilli (Fig. 9), where the nuclei ramify through the cytoplasm like the giant branching nuclei in the silk glands or ovarian nurse cells of insects[6]. In these remarkable metazoan cells nuclear branching is associated with great cell volume and very active protein secretion; as they grow, their initially spherical, orthodox nuclei ramify throughout the cytoplasm—to some extent preserving the balance between nuclear surface and nuclear volume which is thought to be necessary for the nucleocytoplasmic interchanges involved in protein secretion. The small and inactive resting bacilli present exactly the reverse situation, and their branched nuclei arise by quite a different sequence of events. As the bacteria age there occurs what might almost be described as an 'atrophy' of the nucleus—the cytoplasm increasing in bulk and pinching the ellipsoidal nucleus of the young, actively growing bacterium into the shrunken, branching, aged form; the latter is, of course, smaller in volume than the young nucleus from which it has come—in contrast to the branched silk gland nuclei, the volume of which greatly exceeds that of the young nuclei from which they arise.

The reason for the uneven shrinkage of these bacterial nuclei is by no means settled; but it may be related to the fact that the nuclear membrane (if such exists) is rather tenuous and difficult to distinguish, in marked contrast to the distinct, usually double, nuclear membranes, some 250 A. thick, observed in sections of many animal and plant cells. Only in dividing paracolon bacilli (Fig. 10) have we observed nuclei as compact, well defined and strongly Feulgen-positive as those of staphylococci.

Paracolon bacilli (like *Escherichia coli* and unlike staphylococci, Fig. 1) flatten sufficiently when mounted whole on electron-microscope specimen grids to allow considerable penetration by 50–100 kV. electrons. It has long been known that carefully fixed, whole bacilli often show irregular clearer centres[7] surrounded by a dense peripheral layer, and these clear areas have, without very convincing evidence, been called 'nucleoids'. Our observations confirm this view. Most of the clear areas observed in the intact flattened bacilli undoubtedly result from the large central vesicular nuclei. Indeed, there may well be a correlation between size, or nature, of nucleus and susceptibility to flattening, for the paracolon bacillus with its large vesicular nucleus, presumably containing abundant nuclear sap, is drastically flattened by surface tension forces during drying, even when it remains viable; whereas the staphylococcus, with a nucleus which is both relatively and absolutely much smaller than that of the bacillus, usually preserves its original (nearly spherical) shape very well during drying (Fig. 1). Of course, flattening is also much affected by the shape and nature of the cell wall.

Conclusion

Finally, it is noteworthy that, in contrast to their elaborate nuclei, the two species studied showed little conspicuous structural differentiation in their

cytoplasm. The latter was of fine, granular appearance, with occasional clusters of denser granules (150–400 A. in diameter) in the polar regions of the bacilli, but no true mitochondria. Dividing cocci showed clear indications of the cytoplasmic vacuoles associated with ingrowing cell walls as demonstrated by Chapman and Hillier for *Bacillus cereus*[8]. (See also Birch-Andersen, A., Maaløe, O., and Sjöstrand, F. S., *Biochim. Biophys. Acta*, **12**, 395 (1953), whose paper on electron microscopy of sectioned bacteria appeared after the above was submitted for publication.)

Our main interest, however, has been in the nuclei, both because of their controversial status and because of their possible significance for studies on the evolution of the nuclear apparatus of higher organisms[9]. As regards the existence of bacterial nuclei, our observations confirm and extend the already strong evidence for the presence in bacteria of bodies which in two respects—chemistry and morphology—have much in common with the nuclei of animals and plants. There certainly are differences, for example, the degree of development of the nuclear membranes, but in the present state of knowledge the differences seem less conspicuous than the similarities.

The third major criterion of nuclear identity is behaviour at cell division. It is in this respect that bacterial nuclei appear to differ markedly from animal and plant nuclei, and from this point of view, therefore, they may be of outstanding interest for studies of nuclear evolution. It is perhaps a forlorn hope that the evolution of the protoplasmic organelles of animals and plants can ever be traced by study of modern micro-organisms. But at least it may be possible, without prejudicing any evolutionary issues, to distinguish three main levels of 'nuclear' organization (excluding those small viruses which contain no deoxyribonucleic acid): (*a*) co-existence of deoxy- and ribonucleic acid without such structural adjuncts as chromosomes, nucleoli and well-defined nuclei, clearly distinguishable from cytoplasm—that is, the state of affairs which presumably exists in many small and medium-sized viruses; (*b*) localization of deoxyribonucleic acid and nuclear ribonucleic acid on special structures (chromosomes and nucleoli) within a moderately well-defined nucleus, which, however, divides amitotically—the condition characteristic of the bacteria here described and possibly of some large viruses; (*c*) the animal and plant condition, in which a fully differentiated nucleus divides by mitosis. However, great refinements of cytochemical techniques are needed before the wide variety of micro-organisms already recognized can be adequately surveyed and classified from this point of view.

I am indebted to Dr. R. M. Fry and Mr. R. C. Valentine for supplying me with the bacterial cultures used in this work.

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FISHERIES SURVEY OF THE MAURITIUS–SEYCHELLES AREA

As the result of a recommendation in 1945 by Dr. J. F. G. Wheeler, a Colonial Development and Welfare Research Grant was made available for a survey of the fisheries resources of the Mauritius–Seychelles region of the Indian Ocean. The survey was carried out during the two years 1948–49 by Dr. Wheeler and Dr. F. D. Ommanney, and a comprehensive report has now been published*.

Between the Seychelles and Mauritius and forming with them an arc of a circle, the centre of which, six hundred miles away, is the north end of Madagascar, there is a chain of shallow banks which, except for a few isolated islets, are never uncovered by any tide. The object of the survey was to assess the potential fish resources on and around those banks. The work was carried out mainly in a 70-ft. Scottish-type fishing vessel (M.F.R.V. 1), which made forty-two cruises providing approximately 285½ hours of fishing time. Ancillary observations were made in a schooner and certain other craft from the Seychelles and in small boats and pirogues at Mauritius.

It was found that the only fishable waters for demersal fish are on the banks themselves, as their edges fall away precipitously into great depths. Generally speaking, the best catches were made in depths of 8–42 fathoms, and the hand-line proved to be the most effective fishing instrument. It was, in fact, demonstrated that catching-rates by the simple, inexpensive and fool-proof method of hand-lining equalled those of trawlers using complicated and expensive trawling gear in normal trawling areas.

There are some 3,300 sq. miles of fishable water within an overnight run from Mahé (Seychelles) and 7,500 sq. miles within three days 'steaming' distance at 8 knots. There is very much less fishable water within the same distance of Mauritius; but the extensive St. Brandon and Nazareth Banks are not more than four days 'steaming' distance away.

Pelagic fishes, strangely enough, were also found to be almost entirely restricted to waters inside the 100-fathom line over the banks and close inshore around the islands. These consisted of a wide range of species from giant sailfishes and swordfishes down to mackerels, anchovies, sardines and the like. No method of capturing any of these on a paying commercial scale was discovered, so pelagic fishing is considered to hold fewer prospects of profitable development than bottom fishing.

The demersal fish resources of the region, on the other hand, are regarded as exploitable and adequate for all foreseeable local needs, and there could well be an exportable surplus if an outlet on the East African mainland could be found and developed.

At present the fish stocks of both the Mauritius and Seychelles areas are exploited only in very small

* Colonial Office Fishery Publications, 1, No. 3; 1953. Report on the Mauritius–Seychelles Fisheries Survey, 1948–1949. Part 1: The Bottom Fishes of Economic Importance. By J. F. G. Wheeler. Part 2: The Pelagic Fishes and a Note on Tow Nettings. By F. D. Ommanney. Part 3: Note on Meteorology. By F. D. Ommanney. Part 4: General Considerations and Conclusions. By J. F. G. Wheeler. Pp. ii+145+5 plates. (London: H.M.S.O., 1953.) 40*s*. net.

measure over restricted areas near the inhabited islands. In due time, says the report, development will come, "but the pattern of its realisation is for others to decide". That, of course, must be so, for both Dr. Wheeler and Dr. Ommanney have now left the region; but it would have been helpful if, out of their knowledge and experience, they had offered more precise guidance to those whose lot some day it will be to do the developing. On one point, however, the report is quite clear and emphatic—any power-driven craft that may eventually be used for either fishing or further research on the grounds surveyed must be well-found, mechanically reliable, and carry really competent engineers. Wheeler and Ommanney's survey was beset with far too many avoidable difficulties and disappointments due to machinery failures. In the words of the report, their cruises went forward "under the urgency of impending break down". This applied not to one cruise only, but to all of them, for in the summarized log of the forty-two cruises there are no fewer than twenty-nine entries relating to mechanical failure of one kind or another, arising largely from unskilled attention.

The authors are very well aware that many of their conclusions are based on data that are regrettably 'thin'. In view of the inadequate facilities with which they were provided and the difficult conditions in which they worked, this is not surprising. What is remarkable is that so much was accomplished in spite of the difficulties. This was entirely due to the calibre of those in charge of the survey, and especially to the skill and competence of Skipper Davies, captain of M.F.R.V. 1, who was no less expert in the engine-room than in the wheelhouse; it was due to his skill that on every occasion of machinery failure emergency repairs were made and "the long drift to Africa never eventuated". The measure of the hazards under which skipper and scientists worked (due to the ever-present threat of machinery breakdown) may be gauged from the fact that out of sight of land no other ship of any kind was seen during the entire commission and no contact was possible with either Seychelles or Mauritius on the effective range of their radio-telephone. In short, this survey by Wheeler and Ommanney was a truly heroic enterprise carried out in conditions that no one in an officially sponsored project of this kind should be asked or expected to contend with.

It will be the fervent hope of all those in any way connected with Colonial fisheries development and research that the Colonial Office and its advisers will pay particular heed to those sections of the Mauritius–Seychelles report that emphasize the importance of mechanical efficiency in sea-going vessels. The M.F.R.V. 1 was placed in the "willing but inexperienced hands of local mechanics", and the survey suffered accordingly. Fisheries development in Colonial territories must depend in large measure on power-driven craft. To maintain them in good and reliable working condition, where ordinary servicing arrangements are either poor or entirely lacking, demands engineering skill of the highest order. To attract engineers of the right calibre into such service requires that both salaries and working conditions be really attractive. Salaries but little higher than those obtainable in the United Kingdom or in other less-exacting posts will attract only low-grade talent with its attendant low efficiency. Such parsimony is entirely false economy. True economy lies in attracting and keeping staff of such quality that worth-while results will be obtained despite difficulties. Projects that flounder or founder through lack of talent in those entrusted with the work are wasteful in the extreme, no matter how tight-fistedly they are financed.

G. A. Steven

THE HOXNE INTERGLACIAL RECONSIDERED

By R. G. WEST

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THE Interglacial deposits at Hoxne, Suffolk, occupy a critical position in the Pleistocene stratigraphy of the British Isles. They directly overlie the Kimmeridgian Boulder Clay, contain an Acheulean industry and are covered by deposits of a later glaciation. The dating and the stratigraphy of the deposits are therefore of great importance. New evidence concerning both has recently been obtained by the application of pollen analytical methods and by an extensive programme of boring.

The deposits have been described in detail by Prestwich[1], Clement Reid[2] and Reid Moir[3,4]. The accepted scheme of stratigraphy is based on the work of Clement Reid and Reid Moir. The succession described by Clement Reid and his climatic inferences from the plant remains are shown in Fig. 1 *a*. Later, Reid Moir described sections in the Oakley Park pit which showed that the Palæolithic Loam rested directly on the Kimmeridgian Boulder Clay and was overlain by a deposit he believed to be glacial, and that it contained a temperate fauna and flora. He accepted Clement Reid's scheme of the stratigraphy and considered the Palæolithic Loam or so-called "upper temperate brickearth" to be younger than the beds *B*, *C*, *D* and *E* of Clement Reid, although it lay directly on the boulder clay. He was then able to complete the climatic succession to the top of the deposits. The resulting scheme of stratigraphy and climatic change, shown in Fig. 1 *a*, is a composite one, as the beds attributed to a position above the gravel *B* were described by both Clement Reid and Reid Moir from sections at the north and west faces of the Oakley Park pit, whereas the older beds *B*, *C*, *D* and *E* were described from the south-west corner of the Old Brickfield, on the opposite side of the Eye–Hoxne road, where the full presumed sequence could not be seen.

The pollen diagram obtained from an excavated section on the west face of the Oakley Park pit, at point 1 in Fig. 1 *b*, is exactly similar to the diagram obtained from the cores of a deep boring made at point 2, Fig. 1 *b*, in the south-west part of the Old Brickfield. The similarity of the pollen diagrams shows that Clement Reid's Palæolithic Loam and bed *E* are of the same age. A large number of borings made in the area gave the stratigraphy shown in Fig. 1 *b*. Both the pollen analytical and stratigraphical evidence prove that there is only one

temperate horizon in the Interglacial deposit. The error made by Clement Reid and Reid Moir in differentiating the Palæolithic Loam from the bed *E* was probably due to the difference in their appearance, for where bed *E* rises to near the surface, as it does in the north and west parts of the Oakley Park pit, it is weathered to the mottled colour characteristic of gley horizons of waterlogged soils.

The pollen diagrams from the beds *C*, *D* and *E* of Clement Reid show a succession from late-glacial conditions at the base of bed *E* to temperate conditions at a higher level. There is a marked and sudden change in the diagrams at the interface of beds *D* and *C* which probably represents an erosional unconformity, so that the diagrams do not cover the whole Interglacial period. The climatic inferences from the pollen analytical results are shown in Fig. 1 *b*.

The thick and compacted lacustrine beds must represent a long period of deposition. The pollen diagram indicates that they probably belong to the Great Interglacial (Elster/Saale or Mindel/Riss Interglacial). The diagram is not of the type characteristic of the Last Interglacial in north-west Europe. In the presence of an *Abies* (silver fir) zone after the temperate deciduous forest phase it resembles the diagram from the Clacton Channel[5], but differs from that of the Cromer Forest Bed given by Woldstedt[6]. The deposits also contain *Azolla filiculoides* Lam.[7], a plant found in many deposits in north-west Europe which are dated to the Great Interglacial on geological evidence, but which has not yet been found in the Last Interglacial. There is no doubt that the basal boulder clay immediately precedes the lacustrine deposits, suggesting that this boulder clay probably belongs to a late part of the Elster Glaciation of northern Europe. The lithology and fabric of the overlying clayey sand and gravel indicate that they are in a primary position and were not deposited by solifluxion processes. The period of their deposition would then be the Saale.

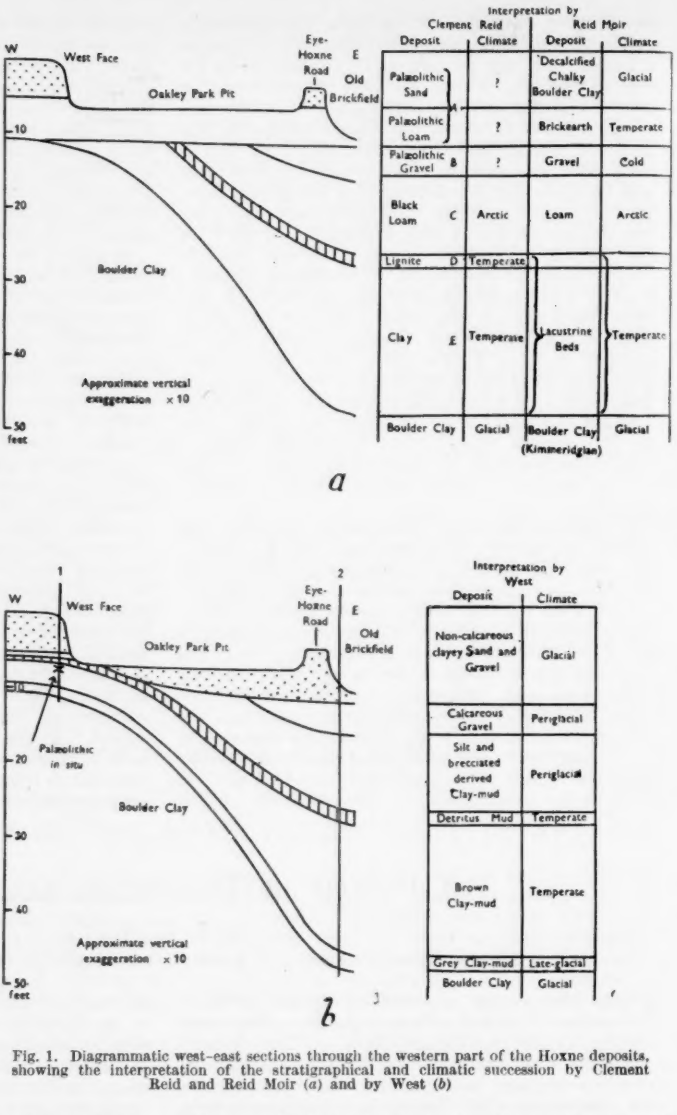

Fig. 1. Diagrammatic west–east sections through the western part of the Hoxne deposits, showing the interpretation of the stratigraphical and climatic succession by Clement Reid and Reid Moir (*a*) and by West (*b*)

The relation of the archæology to the stratigraphy has been examined closely and there appears to be evidence for a single archæological horizon in place in the temperate brown clay-mud (bed *E* of Clement Reid), at the level marked *X* in Fig. 1 *b*. It is probable that the Acheulean industry is referable wholly or in part to this horizon, an attribution conforming with Baden-Powell's recent assessment of the material as "Late Middle Acheulean"[8].

A full account of the stratigraphy, palæobotany and archæological stratification is in preparation and will be published elsewhere, together with some of the consequences for the revaluation of the East Anglian glacial sequence as a whole.

The work has been carried out at the Subdepartment of Quaternary Research, Botany School, University of Cambridge, under the supervision of Dr. H. Godwin, during the tenure of a Nature Conservancy studentship. The deep boring was paid for by the Royal Society of London, and the Suffolk Naturalists' Society assisted in payment for certain of the excavations. We gratefully acknowledge the assistance given by both bodies.

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OBITUARIES

Prof. Norman M. Comber

NORMAN MEDERSON COMBER died at his home in Leeds on December 5, within three months of his retirement from the chair of agricultural chemistry and the office of head of the Department of Agriculture in the University. His retirement brought to a close a period of forty years service in the University of Leeds, during the last four and a half years of which, though beset by serious illness, he nevertheless continued with conspicuous courage to play a full part in the affairs of his Department. His death will be regretted by agricultural scientists and agricultural educationists everywhere, and not least by his many friends who had hoped that he might enjoy a well-earned period of retirement; and all will wish to extend their sympathy to his widow who, with a son and daughter, survives him.

Comber was a native of Brighton and graduated in 1909 after studying chemistry at the Royal College of Science, London. His first professional appointment was at the East Anglian Institute of Agriculture at Chelmsford, where his life-long interest in soil science was awakened and whence, in 1913, he came to the University of Leeds to join the staff of Prof. Charles Crowther, whom he succeeded in the chair of agricultural chemistry in 1924. In 1932, on the retirement of the late Prof. R. S. Seton, he became head of the Department of Agriculture and was responsible for its direction until his retirement, under the age limit, in September last.

Comber's researches, which have brought distinction to his Department and the University, were chiefly concerned with the aggregation of soil particles and were published in numerous papers in various scientific journals. His name will long be remembered in connexion with the 'Comber test' which he devised for the detection of sourness in soils. His research activities, however, were latterly increasingly limited by administrative responsibilities involved in the direction of a department which was concerned not only with intra-mural university work but also with extra-mural advisory and educational activities among farmers in the county of Yorkshire until, in 1946, these latter became the responsibility of the National Agricultural Advisory Service and the county councils, respectively. He was deeply interested in agricultural education, and his wide and varied experience led him to develop clear and strong views concerning the training of agriculturists and agricultural scientists. He was convinced that the optimum training for the agricultural scientist was one based upon pure science, a conviction which led in recent years to the establishment in the University of Leeds of postgraduate courses in agricultural sciences for pure science graduates. Nor was his interest restricted to education at the university-level, for he was responsible for the successful organization of day-continuation classes in agriculture for school-leavers in Yorkshire and did pioneer work in the establishment of the Yorkshire Federation of Young Farmers' Clubs.

During his forty years service in the University of Leeds, Comber played a full and active part in its affairs, as member of Court, Council and Senate, dean of the Faculty of Technology, chairman of the Board of Science and Technology, president of the Priestley Club and member of many committees. He had a profound interest in students and their welfare which continued long after they had left the University. He was actively associated with many scientific and professional bodies. As secretary and later chairman of the Yorkshire Section of the Society of Chemical Industry, chairman of the Yorkshire Branch of the Rural Community Council, member of council and of the executive committee of the Rural Community Council, chairman and afterwards treasurer of the Agricultural Education Association, he gave ungrudgingly of his time and energy. He was a distinguished foundation member of the International Society of Soil Science, and had actively participated in its meetings not only in Great Britain but also in Italy, Hungary, the U.S.S.R. and the United States. The British Association for the Advancement of Science recognized his eminence as an agricultural scientist by electing him president of Section M in 1949, and shortly before his death the Agricultural Education Association, with which he had been actively associated since 1912, conferred honorary membership upon him in recognition of his outstanding services to agricultural education.

For many years Comber gave devoted service to the Baptist Church as lay preacher and deacon, and in 1938 the Baptist community in Yorkshire conferred upon him the highest honour they could bestow by electing him to the presidency of the Yorkshire Association of Baptist Churches.

All who studied under Comber or worked in close association with him will remember his genial personality, his acute, agile and critical mind, his meticulous attention to administrative detail and his mastery of both the spoken and written word; and they will recall his unquenchable sense of humour, which was evident even latterly in the face of a physical affliction which he bore uncomplainingly and with the greatest fortitude and courage.

J. S. WILLCOX

Prof. J. O. Wilhelm, O.B.E.

JOSEPH OSCAR WILHELM, director of the Research Council of Ontario, died in Toronto General Hospital on November 19, after a short illness. His death at the age of fifty-four has cut short a distinguished career.

Prof. Wilhelm was born in the village of Shakespeare, Ontario. Educated at the University of Saskatchewan and the University of Toronto, he lectured in the Physics Department of the latter university from 1927 until 1948. He served, on leave of absence in the Second World War, as technical assistant to the president of Research Enterprises, Ltd., with the National Research Council of Canada, with the R.C.A.F. as director of operational research, and with the federal Department of Reconstruction.

Following the War, he was secretary of the Ontario Research Commission during 1945–48, the work of which resulted in the establishment of the Research Council of Ontario. As director of the Council since 1948, his energy and ability were largely responsible for the organization of more than two hundred and fifty representatives of industry, government and universities in various research committees concerned with technical problems affecting Ontario's natural resources and the supply of scientists. In this work his deepest faith lay in new generations of students whose possibilities inspired his efforts.

In addition to many other affiliations, both in community organizations and professional groups, he was first vice-president of the Royal Canadian

Institute and chairman of the board of Knox Theological College, Toronto. He was well known to many scientists in Britain and the United States. A recognized authority on low-temperature physics, he was equally at home with men and ideas. His bent for organization sprang from his imaginative grasp of problems outside his own field, his fresh and stimulating spirit, and his capacity for friendship. Always willing to attempt the difficult, he was devoted to the public welfare. His early death was a shock to his many colleagues and friends, a great loss to Canada and the community in which he lived.

In 1927 Prof. Wilhelm married Nan Kathleen Munro of Saskatoon. He is survived by his widow, a son Donald who is at present in England, and a daughter Mildred still attending school.

W. J. Mackey

Mrs. E. M. Reid

Mrs. E. M. Reid, the noted palæobotanist, died on September 28 in her ninety-third year. The daughter of John Copner Wynne Edwards, of Denbigh, she was educated at Westfield College, and taught mathematics at Cheltenham; she turned to geology and botany after her marriage to Clement Reid, of the Geological Survey, in 1897. Reid was a pioneer in the study of fossil fruits and seeds of the later geological formations, and Mrs. Reid threw herself wholeheartedly into this work, devising or improving techniques for extracting plant remains from peat, and bringing a methodical and highly critical intelligence to the study of the seeds and fruits so obtained. At that time it was by no means generally accepted that specific identifications were possible from isolated seeds and fruits, let alone from imperfect or fragmentary specimens which might have undergone alterations due to incipient fossilization. By a close study of the fruiting organs of living plants, however, the Reids proved conclusively that floral assemblages of the comparatively recent past could be reliably reconstructed from deposits which contained abundant fruits and seeds. Working backwards from Holocene and Pleistocene floras, their joint studies culminated in an extensive memoir on the "Pliocene Floras of the Dutch-Prussian Border" (1915). In 1916 Clement Reid died, only three years after retiring to Milford-on-Sea in Hampshire; his widow remained there for the rest of her life, and with great determination continued her palæobotanical research. She described preglacial floras from Durham, with an important "Comparative Review of Pliocene Floras" (1920), and from then on was constantly consulted for determinations by botanists and geologists in various European countries.

After being joined by Miss M. E. J. Chandler, Mrs. Reid pressed her investigations farther back into the Tertiary, and in 1926 the British Museum (Natural History) published a volume by the two authors on the Bembridge (Oligocene) flora of the Isle of Wight, based on the a'Court Smith collection which had been acquired for the Geological Department of the Museum. Mrs. Reid was then asked to study, in conjunction with Miss Chandler, the extensive collection of pyritized fruits and seeds from the Eocene London Clay, which had been in the British Museum for more than a century. Seven years intensive work produced the "London Clay Flora" (1933), which at once took its place as a classic of Tertiary palæobotany. In the introduction to these two monographs, and particularly the second, Mrs. Reid analysed with great lucidity the phytogeographical, climatic and evolutionary significance of the European floral succession throughout the Tertiary, as revealed by studies of angiospermous fruits and seeds. Certainty of identification depended on morphological and anatomical structure, which in turn threw light on secular changes of character within genera and families; biogeographical alliances of genera represented in fossil floras showed an increasing correlation in past Tertiary periods with present floras of the Far East, until finally the Eocene of southern England proved to have a tropical flora related to that of the present Indo–Malayan region.

After the work on the London Clay, Mrs. Reid undertook no major commitments, though she published a number of short papers either alone or with Miss Chandler, who lived with her and with whom she continued to discuss further studies on Tertiary floras of southern England. The final results of this prolonged research are now being prepared for publication by the Trustees of the British Museum.

Mrs. Reid and her husband lived most frugally; her life was strictly ordered with a disciplined austerity; she was critical but charming, and could always find time to assist other inquirers. She was devoted to her church and other local affairs, and found solace in reading, particularly books of travel. Her scientific work was the outcome of steady perseverance combined with originality and an analytical mind.

W. N. Edwards

Dr. G. H. H. Tate

Dr. George Henry Hamilton Tate, who died in Morristown, New Jersey, on Christmas Eve at the age of fifty-nine, was curator of mammals in the American Museum of Natural History, New York.

Dr. Tate was born a British subject, on April 30, 1894, in London. He served in the Army during the First World War, and afterwards went to the United States, where, in 1921, he became a field assistant of the American Museum of Natural History. In 1927 he became an American citizen, and in the same year graduated as a bachelor of science of Columbia University, taking his master of arts degree in 1931. In the same year he was appointed assistant curator of South American mammals in the American Museum of Natural History, which post he held until 1942, when he was made associate curator of mammals, and later, in 1946, curator of mammals. In 1937 he was made a doctor of science in the University of Montreal. During the Second World War he served as chief of rubber explorations for the Defence Supplies Corporation at Washington.

During the course of his time at the American Museum, Dr. Tate went on forty-two collecting expeditions, to South America, New Guinea and Australia, as well as to West Africa. These expeditions, many of them carried out in association with Mr. Richard Archbold, led to an imposing series of monographs, those on the Chiroptera, Rodentia and Marsupialia being of particular importance.

Dr. Tate came fairly regularly to England, where his mother still lives, and his work brought him for weeks at a time to the British Museum (Natural History), where the staff of the Mammal Room were always glad to welcome him, together with his wife Eleanor who survives him.

T. C. S. Morrison-Scott

NEWS and VIEWS

Applied Mathematics in King's College, London: Prof. H. Bondi

THE vacancy in the professorship of applied mathematics at King's College, University of London, created by the departure of Prof. G. Temple to Oxford, has been filled by the appointment of Mr. H. Bondi, at present University lecturer in mathematics at Cambridge. Mr. Bondi entered Trinity College, Cambridge, in 1937 and was placed in the first class (Wrangler) of Part II of the Mathematical Tripos in 1939. His career was prevented from following the usual course by the outbreak of war, during which he engaged in important theoretical and experimental problems for the Admiralty. In 1943 he was elected to a research fellowship at Trinity College, and in 1952 to a staff fellowship.

Mr. Bondi's researches have been in a wide range of topics in mathematical physics, theoretical astronomy, and geophysics. Gifted with the degree of mathematical aptitude one associates with Cambridge and Trinity College, and possessed of a deep appreciation of the philosophical aspects of science, Mr. Bondi found suitable material for the application of his talents in the new ideas in astronomy that had been developing in recent years. His earliest papers were on such subjects as the theory of shock waves, of the mechanism of accretion, and the development of special methods for dealing with the refractory equations that govern stellar structure. In geophysics his work has been concerned with important hydrodynamical problems of the motion of the fluid core of the earth resulting from precession and the retardation of the earth's rotation. More recently, Mr. Bondi's name has been closely associated with the renewed activity in the field of cosmology, and in particular with the hypothesis of the continuous creation of matter, which is generally accepted by astronomers to be one of the most profoundly daring ideas yet introduced in astronomy. Mr. Bondi's wide reputation brings him into considerable demand as a lecturer, and twice during recent years he has been invited to the United States. In 1950 he visited Cornell University with a research appointment, and again in the autumn of 1953 he visited Harvard College Observatory to deliver lectures.

South Wales Laboratories of the British Iron and Steel Research Association: Mr. D. Luther Phillips

MR. D. LUTHER PHILLIPS, who will retire in February under the age-limit from his post as head of the South Wales Laboratories, Sketty Hall, Swansea, of the British Iron and Steel Research Association, graduated in 1911 with honours in chemistry at the University College of Wales, Aberystwyth, and was later awarded an 1851 Exhibition industrial bursary at Baldwins Iron and Steel Works, Landore, Swansea. During the following years he became successively chief chemist and metallurgist, blast-furnace manager and (in 1928) works manager of the Landore works. In 1931 he was appointed senior research officer to the local steel and tinplate associations at the Metallurgy Department, University College, Swansea, and his work at Swansea on strain age-hardening culminated in a joint paper with Dr. C. A. Edwards and Mr. H. N. Jones on "The Influence of Some Special Elements on the Strain Age Hardening and Yield Point Characteristics of Low Carbon Steels", which excited much attention, indicating a new and fruitful approach to this problem. In 1946 Mr. Phillips became head of the Laboratories at Sketty Hall, where he has done much to inspire the team working there on problems of coatings and steel surfaces.

Dr. J. Pearson

MR. PHILLIPS is to be succeeded by Dr. J. Pearson, at present head of the Chemistry Department of the British Iron and Steel Research Association. Dr. Pearson graduated in 1933 in the University of London, gaining his M.Sc. a year later for research in organic chemistry, and then joined the Research Department of Tube Investments, Ltd., to carry out work in connexion with the manufacture of steel tubes and allied products. During 1937–46 he was employed in the explosives branch of the Armament Research Department, Ministry of Supply, and obtained his doctorate in 1946 for research work on the polarography of organic compounds. In 1946 Dr. Pearson became head of the Chemistry Section of the Swansea Laboratories of the British Iron and Steel Research Association, where he was largely concerned with problems on the disposal of spent pickle liquor, and was appointed head of the Chemistry Department in February 1950.

Sir James Frazer, O.M., F.R.S. (1854–1941)

JANUARY 1 marked the centenary of the birth of Sir James George Frazer, in whose works a new science, the comparative study of primitive religions, was established. After graduating at Glasgow, Frazer became a scholar of Trinity College, Cambridge, thus beginning his long and happy residence there. He was afterwards elected to a fellowship at Trinity, which was thrice renewed and finally held for life, the total period being more than sixty years. Although his early work was on the classics, he soon turned towards the study of primitive religions, though his interest in the classics remained strong, as witness his five-volume work on "The Fasti of Ovid", published in 1929. In applying the comparative method to the study of religions, his aim was to regard them not as systems of truth or falsehood to be demonstrated or refuted, but as phenomena of consciousness to be examined like any other aspect of human nature. Many of his researches are embodied in "The Golden Bough". This great work developed slowly. As originally published in 1890, it was in two volumes. The second edition, which appeared in 1900, was in three volumes. Research continued, and finally, between 1911 and 1915, the great third edition in twelve volumes was produced. His friend Anatole France said of him: "Frazer nous a donné de l'homme la connaissance la plus vaste et la plus neuve. Il nous a fait entrer dans la pensée des barbares d'aujourd'hui et des temps lointains; il a substitué aux fables que l'homme imagine pour expliquer sa propre origine les premières données d'une science rigoureuse, qui n'existait pas avant lui". When he died in his eighty-eighth year, a life of long-sustained industry had ensured the permanent recording of the results of researches that have a profound significance for mankind.

The B.B.C. "Science Survey": Dr. Archie Clow

ON February 4, Mr. Eric Simms is broadcasting in the B.B.C. Home Service on "Badgers: their Vocabulary and Language". This talk will be the 250th to be produced by Dr. Archie Clow, of

the British Broadcasting Corporation, in the series now well known as "Science Survey". This series has proved to be a remarkable achievement. Sir Edward Appleton said at the British Association meeting at Liverpool in 1953 that: "You have not really got to the bottom of the matter yourself if you cannot explain it to the man in the street"; Dr. Clow has always seemed to bear this in mind when selecting his speakers for Science Survey. Nevertheless, he has also always insisted on substance in these broadcasts and an absence of 'talking-down' to the listener. Scientific material, even that of immediate human or sociological or industrial importance, is sometimes very difficult material when being prepared for interpretation to the non-scientist, either by radio or through the newspaper press, yet it is possible to hold the interest of a listener or reader once his interest is captured at the initial stages. But this needs careful preparation and handling, and it seems that here Dr. Clow has revealed a genius for production. It is good, therefore, to have the opportunity on this 250th anniversary to congratulate Dr. Clow on his excellent work in scientific exposition and interpretation through the medium of the radio.

Science and Foreign Relations in the United States

While the symposium of papers contributed to the September issue of the *Annals of the American Academy of Political and Social Science* gives a clear factual account of the part that the United States Congress plays in the foreign relations of the United States, it will disappoint those whose hopes had been raised by the appearance of the Berkener report on "Science and Foreign Policy". Following some account of the constitutional position of Congress and of the part it has played before and after 1900, the functions of Congress in foreign relations are explained and then the relations between legislature and executive. Nowhere, however, not even in the concluding discussion of the future of Congress in foreign relations, is any reference made to the recommendations of the Berkener report, and it would seem prudent to conclude that the likelihood of these recommendations being implemented is slight. The influence which science exerts on the foreign policy of the United States in the foreseeable future is likely to be negligible, at any rate until the public discussion of nuclear energy problems considered by Dr. J. B. Conant as desirable is also possible.

Insect Enemies of Western Forests of the United States

A field manual by F. P. Keen on "Insect Enemies of Western Forests" has been issued as a revised edition by the United States Department of Agriculture (Misc. Pub. No. 273; pp. 280; Govt. Printing Office, Washington, D.C., 1952; 1 dollar). It is a very practical illustrated manual covering a wide range of forest insect pests, and written for the use of forest rangers, field-men and others responsible for the protection of the forest resources of the United States. The *raison d'être* is to bring together in summary form published bulletins, articles and records and also unpublished reports. The manual is restricted to insects found in forests west of the Great Plains, roughly the 100th meridian. In dealing with the control of the important bark beetles, of which some details of costs are given, the author correctly says: "At the best, remedial bark-beetle control is only a temporary expedient or a method of suppressing outbreaks that have been brought about through some interruption or disturbance of the biological balance". The only permanent protection to forests is by the maintenance of the natural balance.

Fossil Water-Ferns

A note in the *Transactions of the Suffolk Naturalists' Society* (8, Pt. 2) describes the discovery of two genera of water-ferns, *Azolla* and *Salvinia*, in interglacial deposits in Suffolk. Both these genera are new to the British Pleistocene flora, but have been found in interglacial deposits on the Continent. *Azolla* was found in the deposits at the classic site of Hoxne, and *Salvinia* in the interglacial deposit at Bobbitt's Hole, near Ipswich. Only the male and female spores of the plants have been found so far. The spores of the fossil *Azolla* are very similar to those of the modern *A. filiculoides* Lam., a species which was introduced into Britain towards the end of the nineteenth century. The species of fossil *Salvinia* has not yet been determined. (See also p. 187 of this issue.)

Potassium Absorption by Growing Root Cells

Using a technique, which is described, R. Brown and P. M. Cartwright (*J. Exp. Bot.*, **4**, 11, 195; 1953) have shown that when thin serial sections of maize root, taken from the apex backwards, are immersed in 0·01 *N* solution of potassium chloride in water and in 2 per cent fructose, absorption of potassium by the distal or tip section, which consists almost entirely of meristematic cells, is abnormally low. This is attributed to the absence of a tonoplast surrounding a central vacuole in the cells of this region. The data for potassium absorption are presented in various ways, but when they are reduced to a unit cell basis they show that, per cell, absorption increases as expansion occurs in the root. This is ascribed to an increasing protein content. It is shown that during cell growth in the root, the cytoplasm differentiates in such a way that absorption per unit protein increases. When sugar is provided, the rate of absorption is always stimulated, though the effect of it on final concentration varies with the extent to which the tissue grows. Although when the root is sectioned the rate of absorption is lowest in the meristem, nevertheless this is the region of highest potassium concentration in the intact root. The mechanisms which may be involved in the different circumstances are discussed.

The Flamanville Granite in Normandy

In 1894 Michel-Lévy published a memoir on the Flamanville Granite, long regarded as a classic, in which he recorded evidence indicating that the granite had been produced *in situ* from the pre-existing rocks. Dr. N. R. Martin has recently carried out a structural study of the mass (*Quart. J. Geol. Soc.*, **108**, 311; 1953), using the techniques originated by the late Prof. Hans Cloos. Dr. Martin considers that the granite was emplaced as a diapir that forced its way through a belt of incompetent rocks—already folded on general east–west axes—which were readily buckled still further and thrust aside. The directions of the primary flow-planes of the granite minerals and of the foliation of the surrounding hornfelses are said to be consistent with the conception that the granite was forcefully intruded through a 'neck' below what is now the eastern side of the mass. As the resulting pluton was

continually fed with magma, it became inflated within a plastic cover, somewhat like an expanding balloon. In contradistinction to earlier views, it is concluded that, although metasomatism, feldspathization and assimilation of stoped blocks have undoubtedly occurred along the contacts, these processes are to be regarded as only incidental to the emplacement of the mass as magma. It is noteworthy that Dr. Martin states that the xenoliths detached by stoping "added to the volume of the magma" and that "their assimilation changed its composition". Thus no attempt is made to solve the space problem by stoping. On the other hand, the hypothesis of shouldering aside the country rocks has a serious weakness which is revealed by the 'balloon' analogy. Balloons frequently burst, and the Flamanville 'balloon' would surely have done so as its roof was torn apart by the underlying expansion. Once volcanic activity began, and that would probably be at an early stage, magmatic pressure would no longer be available for thrusting aside the walls. Speculation apart, however, Dr. Martin has made an important contribution by presenting genuine evidence that the mass is intrusive. Evidently the problem of emplacement is much more intractable than was previously supposed.

Personnel Officers in Industry

An interesting comment on the changing climate in industry is revealed in the annual report of the Institute of Personnel Management for 1952–53. The Institute is an association of men and women concerned with the personnel function of management. In 1922 the total membership amounted to 398; in 1937 this number had increased to 613. By 1942 this total had increased to 1,633 and, by 1952, had leaped to 3,806. The figures are ample evidence of the increased attention which is being paid to the human factor in industry. The report also directs special attention to developments in the retail trade and the continued emphasis on training, especially management training, as well as the extended contacts which have been built up in countries overseas.

National Research Council of Canada: Review for 1953

The National Research Council of Canada's "Review 1953" (N.R.C. No. 3034; pp. 244+12 plates; Ottawa: Queen's Printer, 1953; 75 cents) gives, as is usual, more detailed and specific information on the work of the Council's laboratories during the year ended December 31, 1952, than is contained in the thirty-sixth annual report of the Council, and includes some later work. It also contains a directory of staff, as of July 1, 1953, arranged by divisions and sections of the Council, covering scientific staff from junior research officers upwards, and particulars of staff serving as representatives of the Council on external committees. Reports of the various committees include particulars of membership as well as, like the reports of several divisions, a list of publications during the year. Of the total staff of 1,955 on July 1, 1953, 535 were scientific, 675 technical, 472 general service and 269 maintenance.

First International Seaweed Symposium

The proceedings of the First International Seaweed Symposium, held in Edinburgh during July 1952 (see *Nature*, 170, 478; 1952), has now been published (pp. 131; from the Institute of Seaweed Research, Inveresk, Midlothian, Scotland, 1953; 10*s.* 6*d.*). The lively contemporary interest in the biology and utilization of marine algæ is indicated by the facts that this Symposium was attended by nearly two hundred people from twenty-one different countries, and that it is proposed to hold a second one in Norway in 1955. The fifty-three papers submitted, and abstracted in this report, deal with phycology, algal chemistry, the commercial utilization of algæ, harvesting technology and world resources. The main effects of the report are to indicate the wealth of biological and chemical problems awaiting investigation, to which the attention of students might well be directed, and the fact that substantial contributions are being made in many countries.

Scholarships for Study Abroad during 1954–55

The British Council has published a booklet giving details of more than a hundred scholarships offered to British students by sixteen foreign countries for study abroad during the academic year 1954–55. The scholarships are intended mainly for graduates and undergraduates of universities in the United Kingdom, but some are also open to those with non-academic professional qualifications. The awards generally provide for free tuition and maintenance, and are tenable for periods varying from four to twelve months. The countries offering scholarships are Austria, Belgium, Brazil, Denmark, Finland, France, Germany, Iceland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and Yugoslavia. The closing date for receipt of applications varies for each country, the earliest date being March 8. Further particulars and application forms may be obtained by sending a stamped addressed foolscap envelope to any British Council office in the United Kingdom, or to the Controller, Education Division, British Council, 65 Davies Street, London, W.1.

N.Z. National Research Fellowships

The Minister of Scientific and Industrial Research, New Zealand, has awarded the four National Research Fellowships to be taken up during 1954 as follows: R. W. Burling, a graduate of Victoria University College, who is at present doing research in geophysics at the Imperial College of Science and Technology, London, and will then undertake special research at the National Institute of Oceanography, London; R. A. Couper, a graduate of geology of Victoria University College, who will study palæobotany at the Sedgwick Museum, University of Cambridge; P. A. Toynbee, a graduate in chemistry and diploma-holder in industrial chemistry of Canterbury University College, who will do research in Britain on the total gasification of sub-bituminous coals at the Birmingham Research Station of the Gas Research Board; H. P. Rothbaum, a graduate in chemistry of Victoria University College, who will study photochemistry at the University of Oxford. National Research Fellowships are offered annually to suitable applicants with postgraduate experience in scientific research to enable them to study in New Zealand or overseas institutions. Each Fellowship is worth £600 a year, with a marriage allowance of £100 a year, and grants of up to £50 for books, fees, etc., and up to £150 for travel are also paid. They are tenable for one year, with possible extension for a further year. The four present recipients, whose ages vary from twenty-seven to thirty-three years, are all members of the New Zealand Department of Scientific and Industrial Research.

Physicists in Britain during July

The Eighth General Assembly of the International Union of Pure and Applied Physics will be held in London during July 7–10 in the rooms of the Royal Society. The business meetings will be attended by delegates from the national adhering organizations of the International Union and by members of the Union's Commissions on Publications and Symbols, Units and Nomenclature; but, in order to profit by the fact that a number of distinguished foreign scientists will be in Britain for the occasion, a number of conferences on physical subjects have been arranged. Under the auspices of the International Union, two conferences will be held during July 13–17: one in Glasgow on experimental and theoretical nuclear physics, under the chairmanship of Prof. P. I. Dee, at which problems of nuclear structure and properties of mesons will be dealt with; and the other in Bristol on the physics of the solid state, under the chairmanship of Prof. N. F. Mott, at which defects in crystalline solids, and particularly their investigation by the use of microwaves and the relation between dislocations and other defects, will for the most part be considered. During the General Assembly of the Union, three lectures arranged by the Physical Society will be given at the Royal Institution by Profs. J. A. Wheeler, E. Amaldi and Charles Kittel on July 7 and 9 (at 4.30 p.m.) and July 12 (2.30 p.m.), respectively. In addition to these events, a small limited meeting on the mechanical properties of metals will be held during July 19–20 in the Department of Metallurgy of the University of Birmingham under the chairmanship of Prof. M. Cottrell, and the International Commission on Electron Microscopy will be holding a meeting in London during July 16–21.

Chemical Society: Anniversary Meetings in Manchester

The anniversary meetings of the Chemical Society will be held this year in the University of Manchester during March 31–April 2. The proceedings will commence with a symposium on "Dynamic Stereochemistry", arranged jointly with the Manchester Sections of the Royal Institute of Chemistry, the Society of Chemical Industry and the Institute of Petroleum. It is hoped that the speakers will include Prof. C. K. Ingold, Prof. E. D. Hughes, Dr. P. B. D. de la Mare, Prof. E. Winstein (Los Angeles, California), Prof. V. Prelog (Zurich), Prof. D. H. R. Barton and Prof. K. Alder (Cologne). Further details of this symposium can be obtained from Dr. M. A. T. Rogers, Academic Relations Department, Imperial Chemical Industries, Ltd., Dyestuffs Division, Hexagon House, Blackley, Manchester 9. On the following day, April 1, there will be the annual meeting of local representatives of the Society, followed at 11.30 a.m. by the Liversidge Lecture, to be given by Prof. H. J. Emeléus, professor of inorganic chemistry in the University of Cambridge, who will speak on "Organometallic Compounds containing Fluorocarbon Radicals". On April 2 the Society will hold its annual general meeting, and then at 11 a.m. the president, Prof. C. K. Ingold, professor of chemistry in University College, London, will give the presidential address. The afternoons of April 1 and 2 will be devoted to visits to industrial organizations, and all three evenings will be taken up with social events. Further details can be obtained from the Society at Burlington House, London, W.1.

Colonial Service: Recent Appointments

The following appointments have recently been made in the Colonial Service: A. G. Dalgleish (assistant secretary, Office of Member for Agriculture, Kenya), secretary for agriculture and natural resources (general), Kenya; R. F. A. L. Reed (senior agricultural officer, Nigeria), principal of schools, Agricultural Department, Western Region, Nigeria; E. Collins (chemist, Hong Kong), government chemist, Medical Department, Hong Kong; D. A. Frye (senior chemist, Federation of Malaya), chief chemist, Singapore; J. W. Du Preez (senior geologist, Geological Survey Department, Nigeria), assistant director, Geological Survey Department, Nigeria; R. Walls (assistant director, Geological Survey Department, Nigeria), deputy director, Geological Survey Department, Nigeria; C. F. F. Gayle (agricultural officer, Jamaica), senior soil conservation officer, Jamaica; J. H. Haughton (senior agricultural officer, Jamaica), chief agricultural officer (agronomy), Jamaica; E. R. H. Martin (assistant agricultural superintendent, Antigua), agricultural superintendent, Antigua; W. G. Stuart (senior agricultural officer, Jamaica), chief agricultural officer (development), Jamaica; A. D. Swan (meteorologist, Gold Coast), assistant director of observatory, Mauritius; A. K. Auckland, botanist (plant breeder), Tanganyika; T. E. Cobb, agricultural officer, Singapore; M. C. Cronin, J. B. Finney and P. R. MacCrimmon, agricultural officers, Nigeria; K. M. L. Matthews, agricultural officer, Uganda; W. F. Van der Byl Morkel, agricultural officer, Northern Rhodesia; H. Affleck, scientific officer, Federation of Malaya; R. F. Barnes, scientific officer (plant pathologist), Jamaica; P. S. Corbet, scientific officer, East Africa High Commission; C. C. Draper, medical research officer, grade 2, East Africa High Commission; M. J. Holden, scientific officer, Sierra Leone; A. W. Allen, soil scientist, Department of Agriculture, North Borneo; E. W. Fowler, chemist/assayer, Northern Rhodesia; D. A. Livingstone, economist/statistician, Kenya; J. Lucas, fisheries officer, East Africa High Commission; J. Stoneman, fisheries officer, Uganda; G. C. Vickers, veterinary officer, Jamaica; R. A. Wood, chemist, Department of Agriculture, Nyasaland.

The Night Sky in February

New moon occurs on Feb. 3d. 15h. 55m., U.T., and full moon on Feb. 17d. 19h. 17m. The following conjunctions with the moon take place: Feb. 4d. 21h., Mercury 4° S.; Feb. 12d. 05h., Jupiter 4° S.; Feb. 23d. 22h., Saturn 8° N.; Feb. 26d. 05h., Mars 4° N. In addition to these conjunctions with the moon, Mars is in conjunction with Antares on Feb. 25d. 0h., Mars being 5·4° N. Mercury is an evening star, setting at 17h. 45m. and 18h. 50m. at the beginning and middle of the month, respectively; but towards the end of the month it sets about twenty minutes after sunset, when it will be invisible. Venus, an evening star, sets too soon after the sun to be favourably seen. Mars, a morning star, rises about 2h. 15m. throughout the month. At the beginning of the month it lies a little south of γ Libræ, and at the end of the month a little north of α Scorpii (it has already been pointed out that it is in conjunction with this star on Feb. 25). Jupiter, visible throughout the night, sets at 4h. 20m., 3h. 30m. and 2h. 35m. on February 1, 14 and 28, respectively, and is a conspicuous object (stellar magnitude about -2) west of ζ Tauri. Saturn rises at 0h. 50m., 0h.

and 23h. 05m. on February 1, 14 and 28, respectively, and is visible in the morning hours (stellar magnitude about 0·6) north-west of α Libræ. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: February 10d. 23h. 09·7m., 23 Taur. (*D*); Feb. 26d. 3h. 15·8m., α Scorp. (*R*). *D* and *R* refer to disappearance and reappearance, respectively.

Announcements

We regret to record the death, which occurred on January 21 at Christchurch, New Zealand, of Lady Rutherford, widow of Lord Rutherford of Nelson.

Dr. J. Sikorski has been appointed lecturer in textile physics in the University of Leeds.

The Dunlop Rubber Co. has made a grant of £2,000 a year, income tax paid, for the next seven years to the University of Birmingham, partly for general purposes but mainly to establish a Dunlop Fellowship for research work on the chemistry of high polymers, including natural and synthetic rubbers; provision for technical assistance; and the purchase of apparatus not normally available.

In 1947 the Wellcome Trust made a grant of £5,000 for whole-time research Fellowships in schools of pharmacy in Great Britain, and last year this was increased by a further £1,200 when five Fellowships were awarded and the value of each was raised from £350 to £400 a year. The Trust has now announced that it has set aside a further £10,000. The awarding committee, nominated by the Wellcome Trust and the Pharmaceutical Society of Great Britain, has discretion to award a senior research Fellowship at a somewhat higher rate, tenable for two years on an annual basis and renewable in exceptional circumstances for a third year. Fellows must be registered pharmaceutical chemists in Great Britain, or graduates in pharmacy of a British university.

The Ministry of Agriculture and Fisheries is offering the following scholarships for rural workers, or the children of rural workers, of seventeen years of age or more: ten senior scholarships, tenable at universities or colleges, for degree or diploma courses in an agricultural subject or veterinary science; sixty junior scholarships and six extensions for existing holders, tenable at farm institutes, for one-year courses. Selection is by interview only. Further information and application forms (to be completed by March 31) can be obtained from the Secretary, Ministry of Agriculture and Fisheries, Room 313, 1 Cambridge Terrace, Regent's Park, London, N.W.1, or from education offices of County Councils.

Trinity College, Cambridge, is offering as in previous years a number of research studentships and Commonwealth exhibitions, which will be tenable from next October. The research studentships, which will normally be worth £375 a year, are open to graduates of universities other than Cambridge, who are not more than twenty-six years of age, with time spent in national service deductible from age, and who have not already been engaged on advanced study or research for more than two years. The exhibitions are for students from universities of the British Commonwealth, who intend to read for an honours degree, and are worth £40 a year. Applications, to be sent through the head of the candidate's university, must reach the Senior Tutor, Trinity College, Cambridge, not later than April 1 for studentships and May 1 for exhibitions.

The international congress of chronometry organized by the Société Chronométrique de France, which was to have been held in Paris this spring (see *Nature*, November 21, 1953, p. 942), will now be held during October 1–5. Those wishing to read papers should communicate before June 1 with the president of the Society, Prof. R. Baillaud, Directeur de l'Observatoire National de Besançon, Doubs, from whom further information can be obtained.

The Society for Endocrinology is arranging a symposium on "The Technique and Significance of Œstrogen Determinations", to be held jointly with the Endocrinological Section of the Royal Society of Medicine at the latter's premises at 1 Wimpole Street, London, W.1, on February 24, commencing at 10 a.m. Those wishing to attend, who are not members of either Society, should write to Prof. N. F. Maclagan, Westminster Medical School, 17 Horseferry Road, London, S.W.1, for further details.

An advanced course on information work, under the general title of "Organization and Development of Information Services", will be held by Aslib during February 25–28, the first three days being held in the premises of the Department of Scientific and Industrial Research at Charles House, 5–11 Regent Street, S.W.1, and the last day in the Aslib headquarters at 4 Palace Gate, Kensington, London, W.8. The course will be mainly a series of lectures and is planned to be of maximum benefit to information workers with from three to five years experience in the field. The fee for the course is five guineas for members of Aslib and seven guineas for non-members. Further information can be obtained from the Director, Aslib, 4 Palace Gate, London, W.8.

The Ministry of Education is arranging a short course in metallurgy for teachers from technical colleges, to be held in the County Technical College, Wednesbury, during July 14–24. The course, which will be directed by Mr. R. W. Blount, H.M. inspector, assisted by Mr. S. G. Lawrence and other H.M. inspectors, will deal with modern metallographic techniques, mechanical and thermal treatment, modern methods of analysis, and radiographic techniques, and those participating will take any two of these sections. The work will be mainly practical; but there will be certain main lectures which all will attend. The course is residential, and a charge of £13 will be made for the full board and lodging. The tuition will be free. Application forms (Form 106 TSC), which must be returned by May 15, and further information can be obtained from local education authorities.

The Turkish National Institute of Bibliography issues regularly a "Bibliography of Articles Appearing in Turkish Periodicals" which lists, in French and Turkish, articles published during the months covered by successive parts. The entries are numbered serially and arranged according to the Universal Decimal Classification (to two places only); within each section titles are arranged alphabetically by author. A list of periodicals covered is given, together with an author index. Part 4 covers August–September 1952, and includes 3,753 entries.

Errata. In the article entitled "Steric Effects in the Electronic Spectra of Organic Compounds" (*Nature*, January 16, p. 119, col. 1, line 13), for "($\theta_2 = 90$)" read "$\theta_1 = 90$"; line 22, for "$\theta_1 \simeq 0$" read "$\theta_2 \simeq 0$".

SHORTAGE OF GRADUATE TEACHERS OF SCIENCE

At a conference called by the Federation of British Industries in London, on January 14, to discuss the shortage of science teachers in schools, the president, Sir Harry Pilkington, said that the national interest demands that enough science teachers of quality, for all types of educational institution, shall teach and train students in the next few years, so that our scientific and industrial leadership of the world over the next generation may resist challenges. Sir Harry declared that "industry will pay the price of leadership; industry will invest in research, in development, in progress, in expansion and in science. Industry will try to face its obligations towards encouraging a greater national investment in education of this type".

The demand and supply of science teachers was examined by Sir Charles Morris, vice-chancellor of the University of Leeds, who said that in the 1920's and 1930's a really good graduate took a long time to get a public school or good grammar school job as a schoolmaster. In addition, in the 1920's and 1930's, schoolmastering still attracted many able young men from the universities as a worth-while and gentlemanly life. For various reasons this seems to be no longer the case. There is to-day an effective economic demand for these men in research of all kinds, for general posts in industry and for university, college and school teaching.

The peak of this demand has not been seen either for research or for general industry. For university and school teachers the peak may well be reached between 1955 and 1960.

Of the good academic men with fine personal qualities—of whom industry, research and the universities and schools all must have some—there are not enough to go round. Outside the universities and schools they are needed for fundamental and industrial research. A knowledge of the world and human nature is needed to provide the necessary flair and imagination for effective industrial research and for general posts in industry.

Sir Charles questioned whether the undergraduate body of scientists could be increased still further; it is not so easy as might be supposed. Most people agree that our present degree standards are pitched at about the right place, and that a policy of greatly increased admissions should not be advocated if it would lead to large numbers falling by the wayside at the end of the first year. The answer to the shortage of graduate teachers in science is that "we must make sure we are using well all the scientists we have in research and in industry and that we must somehow again make schoolmastering attractive to the young man of spirit, imagination and ambition".

How is this to be done? More and more people are coming to think that the benefits of salary and other differentials must go to good men who actually do the teaching as opposed to good organizers and administrators in the schools.

Dr. A. W. Barton, headmaster of the City of London School, stated that the problem is as much one of quality as of quantity. There are probably two hundred science posts in grammar schools vacant to-day, while both the academic and teaching ability of new science teachers is lower than it was in 1938; 10 per cent of the science teachers are either non-graduates or graduates in arts subjects. In the past ten years, 975 science teachers have left the schools for industry or administration. The shortage of science teachers is now beginning to be felt outside the schools. Two hundred places in university engineering departments were unfilled last October. A hospital medical school in London had 30 per cent of its places vacant at the same time. The science examiners for two of the largest examining boards reported that the majority of last year's General Certificate of Education candidates at Advanced Level passed by learning the work by heart instead of understanding it.

Dr. Barton suggested some possible remedies for this situation which is developing disastrously. A high-level conference representative of all the interests who both train and use scientists should be called to try to secure their fairer distribution. Governing bodies and headmasters should readily give facilities for research to able science teachers, who express a wish to undertake it, probably at a neighbouring university or technical college. Governing bodies should also seriously consider appointing more science teachers to headships of schools.

Science graduates should be deferred from national service if they go into school teaching. The Scientific Civil Service might second some of its scientific officers for, say, five years to the Ministry of Education for employment as school teachers. The universities could foster a rare combination of qualities by instituting general honours courses of three subjects, one of which should be an arts subject, such as English or history, and the others science subjects.

The industrial point of view was put by Dr. P. Dunsheath, chairman of the Federation of British Industries Education Committee, who said that the whole vast field of technology rests on the teaching of fundamental science; "anything which saps at the roots which lie in school science will inevitably have a disastrous effect on the growth of the plant which proliferates through industry".

There is considerable evidence, culminating in the latest report of the Advisory Council on Scientific Policy, to show that Great Britain is already behind some of its important industrial competitors in the application of science. To meet this situation we need not only a restoration of our former standards of science teaching but also a considerable advance on those standards. For the successful operation of an industrial concern there must be mutual respect between the staffs employed in the different sections covering research, development and production, which is fortified by the knowledge that all concerned possess a common understanding of the scientific principles involved.

Industry is more and more alive to the fact that the boy who leaves school at fifteen or sixteen and depends on subsequent part-time education suffers a disadvantage in his climb to the more responsible positions in industry. More boys who now leave at sixteen should remain at the grammar school up to the sixth form, and then take a formal part-time industry-based course in the science and practice of their technology. Such recruits will be very much hampered if they arrive without a good basis of mathematics and science on which to build their technology. Moreover, the very fact of strengthening the sixth form by keeping more boys in touch with

academic life may influence a larger proportion to choose teaching as a vocation.

The question of the balance between teaching in arts and in science is of considerable importance. On the assumption that a good brain may be employed with equal profit in both scientific and arts subjects, the obvious solution is to deflect some of the arts students to science.

Many difficulties will be side-tracked if suggestions for bringing pressure on schools to change their outlook overnight, on local education authorities to increase their wages bill, or on teachers' unions to accept larger differentials, are avoided. All these may be desirable but, from a practical common-sense point of view, should be avoided at present because of their potential for delay. The course least prone to cause delay through vested interests would seem to be not to press for a change in the attitude of the schools but to give opportunities at university entrance for change-over to science and engineering and to provide suitable pre-entry courses for the purpose.

Although the problem is a complex one and there are many possible solutions, industry should not be asked to curtail its intake. Graduates are not being employed wastefully. The urgent need is a larger pool from which both teachers and industrial recruits can be drawn.

NORTH OF ENGLAND EDUCATION CONFERENCE

At the North of England Education Conference, held at Morecambe on January 4, Mr. J. Chuter Ede gave the presidential address in which, reviewing the first ten years of the Education Act 1944, he said that the outstanding disappointment has been the failure to eliminate the competitive examination at the age of eleven. Inadequate effect has also been given to the principles, propounded in the White Paper which preceded the Act, of directing ability into the field where it would find its best realization, and of facilitating free interchange of pupils from one type of education to another. Other disappointments to Mr. Ede were the failure of all but nineteen of the 146 local authorities in England and Wales to submit the development plans based on the Act, which they had originally been required to do in six months, and the failure to correct the bias against craftsmanship and to do more than offer better opportunities for technical education at the secondary stage.

Mr. Ede's main plea was for unity among teachers, parents and authorities; but he offered a welcome warning against straining after uniformity and confusing this with unity. His remarks on technical education were taken up to some extent in a discussion on Tuesday morning which followed addresses by Mr. C. H. Wilson, principal of University College, Leicester, and Dr. P. F. R. Venables, principal of the Royal Technical College, Salford, on the place of the university and the technical college in higher technological education. Mr. Wilson began with a brief review of changes since the Barlow Committee in 1946 recommended the doubling of the output of university graduates in science and technology. While this was virtually accomplished by 1947, all official statements continued to demand a greater output; but it is important to distinguish between graduates in all branches of technology and graduates in fundamental science, and between short-term and long-term requirements for either. On a short-term view, while the supply of scientists is adequate so far as industry is concerned, it is inadequate for schools; but on a long-term view the supply of scientists seems to be reasonably adequate for some time ahead, though the best judges consider that further expansion in technology is still needed.

Discussing the adequacy of the present official policy, Mr. Wilson suggested that there may still be scope for the development of new departments of technology in the newer universities. In the long run the future of technology at the universities will be determined by four factors: the ability to forecast national requirements for the different kinds of technologist; the growth in industry of a much more generous view of the place of development research; the supply by schools of students wishing to take technological degrees; and the development at universities of a consensus of opinion more congenial to the expansion of technological studies. Mr. Wilson said that he recognizes the difficulties and dangers to the academic health of the universities if any one faculty becomes out of balance, and he insisted that the universities have to face the larger questions of the place that technological studies should take in the life of the universities as a whole and the environment in which such studies are best conducted: technology is not necessarily best taught in the environment of a strongly materialistic philosophy.

Dr. Venables's paper was concerned more particularly with the technical college and with its contribution to technological education, which he distinguished carefully from technical education. Compared with the technical colleges, the universities are a small and relatively homogeneous group, and he argued that, in considering the contribution which the technical colleges could make to the expansion of higher technological education, quality not quantity of work is the essential criterion. Technological education he defined as for those who "maintain, manage and maximise industry", with special emphasis on the last two. Of the 422 institutions in England and Wales dealing to a greater or lesser degree with technical education, we need be concerned with no more than those 220, the principals of which qualify for membership of the Association of Principals of Technical Institutions. Further, analysis of the work of these institutions, including the courses they offer, enrolments, recognition by professional bodies, their conduct of research and postgraduate facilities and regional requirements, have convinced Dr. Venables that it is essential to concentrate on some twelve to fifteen only of these institutions. Full university conditions could not possibly be created even for 44 institutions, he said, let alone 220.

Dr. Venables argued realistically that the exhortations and provisions of the Ministry of Education Circular No. 98 on Governance, No. 94 on Research, and No. 255 on Recognized Courses of Advanced Technology do not suffice for the further development of major technical colleges. The increased grant of 75 per cent and the recognition associated with it should on no account be made to an institution the local authority of which has not granted it a properly constituted established governing body with full powers within an approved annual financial estimate. If the local authorities will not or cannot shoulder the financial responsibility involved in the present

grant system, the increased grant, he suggested, should be paid direct to the college and the balance recouped from one or more of the local education authorities concerned. Under such a scheme it would be possible to plan long-term developments—Dr. Venables hinted here at the quinquennial principle—academic freedom could be secured for the staff and residential hostels would be more readily forthcoming. Such major institutions would not be able to provide for all aspects of technological work, and closer links would be desirable with the industrial research associations, which have their own part to play. Nevertheless, he thought that, by increased full-time and sandwich courses, by post-advanced or postgraduate courses and by research in co-operation with industry and the research associations, and further development of management education and training, the fifteen major technical colleges he visualized could make a greatly enlarged and vital contribution to advanced technology in Great Britain.

Dr. Venables's suggestion to concentrate on twelve or fifteen major institutions was supported by Mr. Wilson, and in the discussion Mr. D. J. Williams assured him of the whole-hearted support of the Association of Principals of Technical Institutions. Mr. Williams also advocated a separate major technical colleges committee. There was some general support, too, for the view that the present grants system is weighted in favour of the universities and the arts rather than the technical colleges and the sciences. In his address during the afternoon session on education and the administrative and financial structure of local government, Prof. S. E. Finer, University College of North Staffordshire, presented evidence that, in spite of the steady increase in educational expenditure, local authorities are still not spending nearly as much as they could and should on education; but his address did not bear very closely on the special issues raised by Dr. Venables. Prof. Finer was convinced that we need as strong a local government as can be achieved consistently with national standards, and that it is absolutely impracticable to centralize the administration of the schools. A recalculation of 1938 costs in terms of 1953 prices and school population shows that there has been virtually no increase in that part of the cost of each child's education which falls on local authorities. The real rate burden is very small and has become very much lower than before the War. The case for additional grant seems to be exaggerated, and he thought that local authorities should continue to bear the burden, subject to a reform of the education grant formula to make it more distributive, and based on a rating revaluation in 1956 with provision for a more elastic policy of exemptions and allowances in hard cases.

The sessions on January 6 were concerned with education in other countries, in which Prof. J. A. Lauwerys, University of London Institute of Education, dealt with the situation in the United States, and Dr. G. B. Jeffery, director of the University of London Institute of Education, with the position in the African Colonies. Prof. Lauwerys emphasized the diversity, the size and newness of the American system. There is urgent need, he said, for the development of educational practices which will foster the steadiness of character, power of critical thinking, independence of judgment and the vision that America's new role of leadership demands of her citizens. Of the comprehensive school, he suggested that the British would do well to study with care American experience and then try to avoid repeating the mistakes made by others: one cannot say that because comprehensive schools work in the United States they would work in Britain. On the whole, he thought that the American system is better geared than the British to the imperative requirements of an industrial and technological education, and this aspect also deserves close study. Prof. Lauwerys was also very impressed by the enormous strides which have been made during the past twenty years in developing the professional aspects of the study of education.

Dr. Jeffery's address outlined the rapid progress made by the newly created Gold Coast Government, and in the subsequent discussion Mr. A. L. Binns described the very different conditions in East Africa. Dr. Jeffery maintained that the new development plans of the African ministers to-day, which he believed are fundamentally right in the practical circumstances, in spite of foreseeable dangers, are possible only because of the efforts of missions and the Colonial Education Service over many generations. In East Africa, Mr. Binns thought that the only hope lies in a great reinforcement of the few teams of British technicians and teachers who are already raising moral and material standards in small areas, so that the effort may be sustained long enough for the development of character in African leaders when moral stamina has been undermined by the dissolution of their traditional culture. In this connexion, Mr. T. H. Baldwin urged that educationists should make it possible for British teachers to take short-term appointments in the Colonies without jeopardizing their prospects at home. On January 7, in a paper on the place of the three 'R's' in the curriculum, Miss M. V. Daniel, principal of Hereford County Training College, urged that language, whether in reading or writing, should be envisaged as the means of communicating ideas, and mathematics as an interpretation of the physical world.

AGRICULTURAL CROPS: QUALITY VERSUS QUANTITY

A MEETING of considerable significance to British agriculture was held at Cambridge during December 15 and 16, when the National Institute of Agricultural Botany held its second Crop Conference with the theme of "Varieties in Relation to Crop Production". More than five hundred Fellows of the Institute, including farmers, seed merchants, maltsters, brewers, millers and agricultural scientists, attended to hear papers and discuss the topical problems posed by a quickly changing national and international position in relation to the production of primary agricultural products. The bulging wheat silos of North America and the threats of surpluses of coarse grain from the U.S.S.R. and other countries, coupled with a 'free market' for grain in Great Britain, acted as a stimulating, if sobering, background to the proceedings, and it was a matter of great interest to see how the conference quickly settled down to discuss the economics of quality versus quantity in the production of two of the three crops being considered—barley, sugar beet and wheat.

Dr. H. Hunter introduced the subject of the barley crop, which occupied most of the first day, and

immediately the conference was plunged into the intricacies of crop ecology, the physiology of development, the action of fertilizers, and the relationship between yield and malting quality. Very soon, also, the vital impact of plant breeding on crop production became apparent, and the conflict of interests between the farmer and the brewer, when considering the best varieties to grow, asserted itself. It appeared, however, that the newer hybrid varieties are helping to bridge the gap, and the farmer may not have to decide whether to grow for quality *or* quantity, because it is hoped these hybrids may combine both attributes.

This last point was emphasized by two of the three following papers on barley, in which Mr. C. S. Elliott described the behaviour of the new varieties and unnamed hybrids in the official N.I.A.B. trials, and Commander A. Cory-Wright put the maltsters' and brewers' points of view in considering varietal behaviour and the processors' requirements. Elliott's account traced the changes in barley varieties available in Britain since the advent of Spratt–Archer and Plumage–Archer, which are still generally the maltsters' and brewers' first choice, through the introduction of the Danish variety Abed Kenia, with its stronger straw, earlier ripening and potentially higher yielding capacity of poorer quality grain, to the greatly increased number of foreign varieties of similar type but often of no greater value. The problem has been to try to find a variety combining the desirable grain characters of the Archer barleys with the improved field characters of the Danish and Scandinavian varieties, and considerable progress has been made in this direction with the newest hybrids between varieties representing these two classes of barley. Thus the Danish variety Carlsberg and the English variety Proctor may be considered as real advances in combining higher yield with good malting quality; while other English hybrids are due for release next year.

Cory-Wright's contribution emphasized the change in the varietal position, the dangers of increasing the number of varieties, and the impossibility of making an overall general analysis to cover individual brewer's requirements in spite of a widely accepted interpretation of what is good malting barley. It appeared, however, that growers' and processors' views on varieties were by no means irreconcilable, though a word of warning was given concerning certain new varieties like Herta and Rika with pretensions to being malting barleys but with greater suitability for stock feed. Considerable interest was shown in Dr. A. Eden's paper on the utilization of barley for feeding, and the place of this cereal in the animal's ration, in relation to the composition of the grain.

A different aspect of quality was discussed by Mr. S. T. Skelton, on the afternoon of the first day, when he dealt with the quality of seed stocks. Skelton described the two main aspects of this quality as the appearance—size, colour, and freedom from damage, disease and impurities—and the authenticity and purity of strain or variety. The use of better methods of handling seed with improved machinery, seed testing and seed dressing are important methods of achieving better physical qualities, while the development of seed growers' associations and inspection schemes have done much for authenticity and purity. The speaker acknowledged the very valuable part played by the National Institute of Agricultural Botany in this matter of improved seed quality, which has done much to lay proper emphasis on the importance of the highest standards in seed stocks and of the choice of the best varieties.

The sugar beet crop came in for very different treatment from the barley crop, as might be expected from the difference in the agricultural economy, the processing, and the utilization of the two crops. Mr. O. S. Rose, who dealt with the crop in general, speculated on the reasons for the much increased production per acre of sugar beet, and discussed ways in which varieties could be improved to produce what he described as the ideal sugar beet variety of the future. The list of characters was formidable: regularly-shaped single-germ seeds of high germination capacity, easily processed for sowing in a precision drill; strongly growing plants resistant to disease, bolting and chemical sprays; roots of heavy weight and high sugar percentage with high juice purity; and large tops with neat crowns easily removed by machine. Rose dealt with the practical significance of these characters to the sugar beet and beet sugar industry in Great Britain, making especial reference to the importance of obtaining some control for virus yellows, and he gave warning, from the reported experiences on the Continent, against being optimistic of the benefits of the use of monogerm seed and polyploid varieties. Mr. L. A. Willey elaborated on some of the more important varietal characters already mentioned in describing the results of the N.I.A.B. trials, and made special reference to the importance of bolting resistance (in which the varieties Cambridge *K.N.B.* and Klein *AA* are best), and to the difference in the financial returns resulting from growing the best as opposed to the poorest varieties. These two papers emphasized that in sugar beet there is no conflict of interests between grower and processor when it comes to the choice of variety.

The final session of the conference, on the second morning, was devoted to quality in wheat, four papers being given on this topic. Mr. L. Hector Read, in dealing with the economic aspects of wheat quality, referred to the millers' attitude to milling quality, and the quality of the flour in relation to the use to which it is to be put. Read emphasized the vital importance to the miller of these grain characters, and he pleaded for a greater understanding by the farmer of the manufacturers' needs when choosing the most suitable varieties to grow, because grain quality is such a strongly expressed varietal character. A similar argument was put forward by Mr. Sebert Humphries, who dealt with flour, bread and biscuits from the millers' point of view. Humphries gave an unequivocal account of the requirements of the miller, the characteristics of foreign and native wheats, and varietal differences on the mill. He asked for there to be a purpose in English wheat production and a due regard for the prestige of English wheats, while he made a strong case for the millers' discrimination in buying particular varieties. Mr. E. N. Greer pressed home the very real differences between wheat varieties in the type of flour they produce, and he also gave an account of tests for milling and baking qualities in the laboratory.

These three papers emphasized strongly the conflict of views between the requirements of the farmer on one hand and those of the processor and manufacturer on the other, except in certain types of wheat. Thus, the most acceptable varieties for the miller, who has to consider the manufacturer who

will use the flour, are mostly the 'quality' native varieties like Yeoman and Holdfast, while the farmer prefers the higher-yielding, stronger-straw varieties like Cappelle Desprez and Bersee, and the French-type Hybrid 46 bred in Britain. Occasionally the apparently conflicting requirements are reconciled, as in the variety Atle, while, as in barley, hope for further reconciliation was expressed in the characteristics of new hybrids. Mr. D. G. Bullard put the farmers' point of view, and questioned, as did most farmers present, whether the millers would be prepared to pay an adequate premium for grain quality to compensate for the lower yield of the varieties of accepted quality that are available.

As in the case of barley and sugar beet, the wheat problem was left for the plant breeder to resolve as best he can. The conference brought out most clearly the demand and necessity for further improvement in the varieties of the three crops. The scientific problems posed by such continuous improvement are varied, and the work of improving, testing and sifting the plant material is the foundation of a progressive crop husbandry.

The chairman on the first day of the Conference was Mr. Roland Dudley, and on the second day Mr. Samuel Taylor. Dr. G. D. H. Bell summed up the proceedings on both days. G. D. H. Bell

ANALOGUE AND DIGITAL COMPUTERS

PROCEEDINGS OF THE WESTERN COMPUTER CONFERENCE

THE proceedings of the 1953 Western Computer Conference, held during February 4–6 at Los Angeles, California, under the joint sponsorship of the Institution of Radio Engineers, the American Institute of Electrical Engineers and the Association for Computing Machinery, has now been published* and contains the full text of the technical papers and of the panel discussion, together with résumés of the four addresses, presented at the Conference. The papers were concerned with the application of computers to the handling of business data and to aircraft design and with recent developments in analogue and digital computing equipment. The subject of the discussion was "An Evaluation of Analog and Digital Computers", and the panel of four experts, under the chairmanship of Prof. G. D. McCann, of the California Institute of Technology, consisted of Dr. J. L. Barnes, a mathematician and engineer, Mr. F. Steele, vice-president of Digital Control Systems and an engineer, Dr. L. Ridenour, formerly a nuclear physicist and now vice-president of the International Telemeter Corporation, and Dr. A. W. Vance, an electronics engineer of the Radio Corporation of America.

The addresses were delivered by Dr. Simon Ramo, of the Hughes Aircraft Company, Dr. R. D. Huntoon, of the National Bureau of Standards, Dr. Lee A. DuBridge, president of the California Institute of Technology, and Dr. J. E. Hobson, director of the Stanford Research Institute. Dr. Ramo dealt with the impact of computer development on the training and utilization of engineers. He maintained that the development of computers is work which may soon be engaging the greatest number of engineers and scientists; specially trained graduates with a knowledge of the physical sciences (with emphasis on electronics), the workings of the human brain and business and industrial procedures in addition to government and labour regulations are required, and industry must particularly avoid large programmes until such capable technical experts are available. Dr. Huntoon discussed the factors influencing the effective use of computers and coined the word "psycho-numerosis" to describe the problem of matching computing machines to the needs of research workers. He suggested that "electronic brains", like human brains, in the process of evolution must adapt themselves to their environment in order to survive and prosper.

The complex problem of scientific man-power was the subject of Dr. DuBridge's address. He outlined the salient factors which affect the supply and demand of scientists and engineers and suggested measures to remedy the present inadequate supply. Finally, Dr. Hobson, in an address entitled "New Equations for Management", reviewed the various new factors which the complexity of industrial operations have introduced and indicated how the facts produced by applied research may be properly presented to and utilized by the managements of industrial concerns.

The eighteen technical papers were presented in four sessions. The first and second sessions were devoted to applications of computers to commercial and to aircraft design problems, respectively. The third and fourth sessions dealt with more specific technical problems in the design and use of particular sections or types of computers and included papers on the 'Nordsieck' computer; the new laboratory for three-dimensional guided missile simulation devised by the Reeves Instrument Corporation, New York; an improved cathode-ray tube storage-system; ferroelectrics as a memory element for digital computers; and the solution of partial differential equations by difference methods using the electronic differential analyser.

* Proceedings of the Western Computer Conference held by the Joint IRE–AIEE–ACM Computer Conference Committee, Los Angeles, California, February 4–6, 1953. Pp. 231. (New York: Institute of Radio Engineers, Inc., 1953.) 3.50 dollars.

METEOROLOGICAL OFFICE

ANNUAL REPORT FOR 1952–53

THE Meteorological Office has the task of meeting the civil and Service (except naval) requirements of Great Britain for meteorological information of all kinds and of improving by research its ability to meets those needs. A feature of the report of its work during the year April 1, 1952–March 31, 1953*, is that during this period the organization for the provision of weather forecasts and other information was extended. One example of this was the application to the east coast as a whole after January 31, 1953, of the system of special warnings of meteorological situations known to be associated with coastal flooding, which had been applied successfully to the River Thames in London for many years. Experiments in the transmission by facsimile equipment to selected out-stations of charts drawn at the Central Forecast Office were begun with the view of im-

* Annual Report of the Director of the Meteorological Office for the Year April 1, 1952, to March 31, 1953. (M.O. 573.) Pp. 56. (London: H.M.S.O., 1953.) 2s. net.

proving the information and guidance available to outstation forecasters.

Inquiries for meteorological data and advice covered a wide range of industrial, agricultural and economic problems from the hatchability of hen's eggs to the effect of wind and low temperature on overhead cables and the irrigation of crops.

Much effort was again devoted to the study of meteorological data for high levels, and to methods of forecasting and making observations at these levels in connexion with the increasing demand for information for the navigation of jet aircraft. Charts of upper-air temperature and its variation were drawn on a world-wide scale, and a special study was begun of high-level winds over the tropics. Building began at the new radio-theodolite station at Crawley, Sussex, from which upper-air observations of hitherto unattained accuracy will be made.

In research into methods of forecasting, results of great theoretical interest were obtained from numerical calculations with electronic computing machines. In this work the machine is used to calculate the future pressure distribution from the present one by means of suitably modified forms of the equations of motion of the atmosphere. It is believed that this work is nearing the stage at which it will be of practical as well as theoretical value. Investigations were also made into the formation of anticyclones, and the detailed distribution of rainfall associated with depressions moving along selected tracks over and near the British Isles. Much research work was also carried out into questions of physical meteorology, such as the transfer of heat and humidity between the earth and the atmosphere (a subject of fundamental importance in pure meteorology as well as being very important in agriculture) and the formation of radiation fog. The Meteorological Research Flight carried out an extensive programme of research into problems of cloud physics and flying conditions.

Among the publications produced by the Office during the year may be mentioned a large "Climatological Atlas of the British Isles", "The Century of London Weather (1841/1949)", and a new edition of the "Observer's Handbook".

FOREST PRODUCTS RESEARCH LABORATORY, PRINCES RISBOROUGH

REPORT FOR 1952

THE work of the Forest Products Research Laboratory, Princes Risborough, during the year 1952 is described in "Forest Products Research 1952", the report of the Forest Products Research Board and also of the director of the Laboratory, which was recently published*. During the year there has been little change in the nature and orientation of the Laboratory's work, but there has been a gratifying increase in research work both of the fundamental kind and also in technical projects of the broader sort which can lead to practical generalization.

The testing and evaluation of new tropical species, mainly from the British Colonies, continues to be the Laboratory's major project; but it is expected that the work which began last year on the assessment of home-grown soft-woods from various forest sites of the Forestry Commission will increase in proportion during the coming and successive years. These programmes of timber testing, together with advisory work, continue to occupy much of the available time of the staff. Seasoning and kiln-drying tests have been carried out on tropical hardwoods and home-grown soft-woods. Drying problems of interest are connected with the seasoning of birch for brush heads and the kiln-drying of East African pencil cedar (*Juniperus procira*) slats.

The "Lens Key to the Identification of Hardwoods" was published during the year, and a companion atlas of low-power photomicrographs is in course of preparation. With the help of the "Lens Key" and the atlas as a check, an investigator, even though he lacks access to a standard collection of timber, will be able to identify any of the four hundred timbers, both home-grown and exotic, dealt with in the "Key". The entomological branch of the Laboratory has been engaged on work connected with the excessive damage to imported tropical timbers by ambrosia beetles, the so-called pin-hole borers, so well known to the forest officer in India. The Laboratory has submitted to the Colonial Research Council a programme of research involving the appointment of three biologists as a West African Timber Insect Research Unit to be trained at the Laboratory; it is proposed that one should remain at the Laboratory, and the other two proceed to West Africa in due course, and this step has been approved by the Governments of Nigeria and the Gold Coast.

An unusual item which will interest many is a request by the Brewers' Society to have tests made to find a suitable substitute for oak for making beer barrels. History repeats itself: a century and a half ago the British Admiralty was searching the world for a substitute for oak for the construction of the wooden ships of the Navy, and it found teak; in the case of the beer barrel, the timber so far tested is dahoma (*Piptademia africana*), which has proved unsatisfactory. From beer the report goes to boats, tests having been undertaken as to the best way of making laminated bends for stern, hulls and frames. Work is also in progress on wood structure, timber mechanics and wood-working methods.

E. P. STEBBING

* Department of Scientific and Industrial Research. Report of the Forests Products Research Board, with the Report of the Director of Forest Products, for the year 1952. Pp. vi+62+8 plates. (London: H.M.S.O., 1953.) 3s. net.

OVULATION AND PREGNANCY CORPORA LUTEA IN THE OVARIES OF THE HUMPBACK WHALE

By J. P. ROBINS

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IT has been fairly well established that a permanent record of the number of ovulations remains in the ovaries of whales[1], and this record can be used in the study of the age of the whale. However, to date, apart from attempts by Peters[2] and van Lennep[3] to distinguish between the two types of corpora lutea (more properly corpora albicantia), one resulting from ovulation without subsequent fertilization and

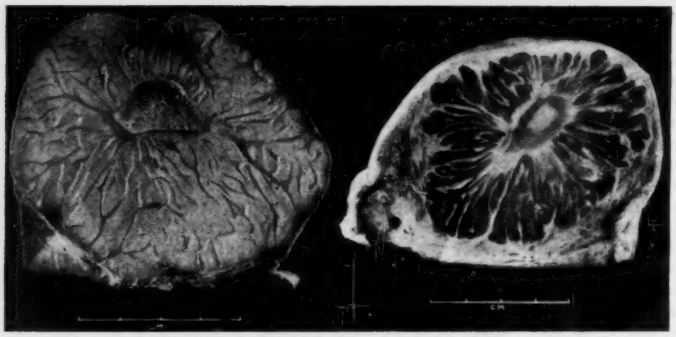

Fig. 1

Fig. 2

Fig. 1. Recently formed corpus luteum of pregnancy showing gel-filled central cavity. From ovary of whale carrying ¼-in. embryo

Fig. 2. Regressed corpus luteum of pregnancy showing connective tissue-filled central cavity

one resulting from pregnancy, no further methods of distinction appear in the literature. Peters assumed the differences in colour and texture of the corpora albicantia to be indications of "ovulation only" and "pregnancy", and made an estimate of the number of ovulations per year in blue and fin whales. Colour appears to be a function of age of the corpora themselves, for the smaller corpora albicantia (apparently the older ones for the most part) are as a rule a much darker coloured orange-brown than those formed later.

Van Lennep made a histological examination of the corpora lutea of pregnancy and regressing corpora lutea in blue and fin whales, and suggested two possible means of distinguishing between old corpora lutea of pregnancy and old corpora lutea of ovulation: (1) arrangement of trabeculæ of connective tissue strands, (2) size of corpora lutea. Corpora lutea of pregnancy possess more connective tissue than corpora lutea of ovulation, and this may be reflected in the sizes of the degenerating corpora lutea. However, the overlap of sizes of the two types of regressing corpora lutea constitutes a problem.

During the winter seasons of 1952 and 1953, at the land-based whaling station at Tangalooma, Moreton Island, Queensland, Australia, many observations on the corpora lutea in the ovaries of the humpback whale (*Megaptera nodosa*) were made, and very particular notice was taken of functional corpora lutea both of early and late pregnancy, and also of the ovaries from females in the early and late stages of lactation. The remarkable feature observed was that in 100 per cent of these cases (thirty-seven individuals of all types) each corpus in question possessed a central cavity, variable in size from individual to individual, but always quite noticeable, this cavity being filled with a gel substance or fibrinous clot or a slight serous fluid. The same close attention was paid to all other corpora lutea in the ovaries, and it was found that a variable proportion of corpora lutea did not possess this characteristic cavity or core.

The close examination of the corpora lutea demands correct orientation and sections no larger than 3 mm. in width.

Dempsey and Wislocki[4] give a description of the ovaries of the humpback whale, and in their summary conclude "that the large size of the whale's corpus luteum imposes certain anatomical peculiarities and physiological limitations on its vascular supply. The luteal arterioles and capillaries are apparently unusually long. The functional restrictions in consequence of the lengthening of these vessels make it impossible for the luteal tissue ever to fill the entire cavity of the luteal body. These limitations result also in nearly complete avascularity of the centre of the corpus luteum associated with excessive fibrosis and hyalinization". Although van Lennep[3] does not agree with this supposition, his statement on size comparisons does not necessarily invalidate it.

In all observations made at Tangalooma, the size of a 'corpus luteum of ovulation' did not exceed 88 mm., while those of late pregnancy and early lactation measured 100–130 mm.

All functional corpora lutea of early pregnancy possessed a central cavity filled with gel substance; but there were also cases where corpora lutea containing gel were not accompanied by an embryo in the very early stages of development in the uterus, although these could have been missed as the Fallopian tubes were not irrigated to discover whether fertilization had taken place. However, the early anatomical changes in the recently formed corpus are not quite clear as yet; but the sequence generally appears to be as follows for (*a*) 'ovulation' only, (*b*) 'pregnancy'.

(*a*) In 'ovulation only', the follicle ruptures and the egg passes to the Fallopian tube. The collapse of the follicle is followed by a rapid proliferation of the luteal cells with subsequent deposition of gel or hyaline substance (due to lag in growth of blood vessels behind the growth of luteal tissue). If pregnancy does not intervene, the gland attains a size of 80 mm., up to which size it appears possible for the blood vessels to supply sufficient blood without further hyaline degeneration into the centre, the luteal cells continuing to grow inward without much further increase in diameter of the corpus (up to a maximum of 88 mm. only), the further growth of luteal cells forcing the central gel to migrate into the deep crypts between the folds of luteal tissue. Apparently this gel, assisted by the adventitial cells

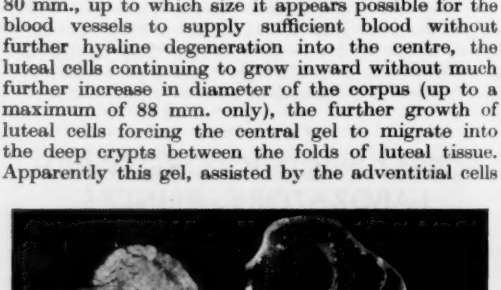

Fig. 3

Fig. 4

Fig. 3. Recently formed corpus luteum, considered to be a corpus luteum of 'ovulation only'. Note absence of a central cavity. No embryo in uterus

Fig. 4. Regressed corpus luteum. Considered to be a corpus luteum of 'ovulation only'

accompanying the blood vessels, later degenerates to fibrin, with the final result that no distinctive centre remains in the corpus. However, two problems attendant on the foregoing postulate are determination of size at which the follicle ruptures and the rate of growth of the corpus luteum eventually formed[5].

(*b*) If pregnancy intervenes, the luteal mass expands still further until the gland attains a maximal size of 100–130 mm. (that is, in late pregnancy and early lactation), with retention of the central cavity. The evidence that the corpus luteum of pregnancy retains the distinctive centre is strengthened by the observation of the only corpus luteum in the ovaries of a whale which carried an 11 ft. 6 in. fœtus dead *in utero*. Regression of the corpus was advanced (43 mm. mean diameter), but the centre remained quite distinct.

That the corpus luteum of ovulation does not possess the centre is further supported by the evidence obtained by the examination of several whales which had ovulated twice without successful fertilization during the seasons 1952 and 1953, and which showed the regressing corpora lutea to lack the characteristic centre distinguishing the corpus luteum of pregnancy.

[1] Mackintosh, N. A., and Wheeler, J. F. G., Discovery Reports, **1**, 257 (1929). Wheeler, J. F. G., Discovery Reports, **2**, 405 (1930). Mackintosh, N. A., Discovery Reports, **12**, 197 (1942).
[2] Peters, N., *Zool. Anz.*, **127**, 193 (1939).
[3] van Lennep, E. W., *Proc. Kon. Ned. Akad. v. Wet.*, **53**, No. 4, 593 (1950).
[4] Dempsey, E. W., and Wislocki, G., *Anat. Rec.*, **80**, 243 (1941).
[5] Chittleborough, R. G. (in the press).

STRUCTURE OF CELL WALL OF *VALONIA*

IT is now more than sixteen years since the crossed fibrillar structure of the cell wall of *Valonia* was first established, and a long and laborious X-ray study completed of the main features of the whole of one particular vesicle[1]. It was concluded that the cellulose chains are oriented for the most part in two, though occasionally three, directions at angles varying between about 60° and 90°, the angle between the dominant pair, however, being generally something less than 90°; and it was inferred that the architectural plan is based on alternating lamellæ in which the microfibrils tend to run in turn along approximate meridians and along left-hand spirals inclined at a roughly constant angle to the meridians.

With the advent of the electron microscope it has been clear for some time that the third microfibril orientation may be more frequent than was indicated by our earlier X-ray investigations. We ourselves have been well aware of this, and attention was directed to it two years ago by Wilson[2]. The matter has now been brought very much to a head by a recent paper by Steward and Mühlethaler[3], in which, from electron microscope studies, they question the validity of our X-ray findings and, in fact, claim to have established that the essential structural plan of the wall of *Valonia* involves not two principal microfibril directions but three, making angles of approximately 120° with one another; in other words, whereas our interpretation requires the microfibrils in successive lamellæ to move back and forth between two orientations nearly at right angles to each other, theirs requires a symmetrical three-fold rhythm, and a succession of three lamellæ, before a given orientation is restored. Without necessarily accepting—in fact, we do not accept—Steward and Mühlethaler's stricture on our interpretation when they say that "the important point here is that wall deposition is conceived to occur by two fundamentally different processes, namely, one which lays down meridians, the other which lays down spirals", it will of course be seen at once that there is a serious discrepancy of some sort, one which lies at the very foundation of our understanding of the architecture of plant cell walls and which it is imperative to explain.

The object of the present communication is not to try to explain it at this stage, and above all, in view of the obvious necessity for still more data, not to take up any definite attitude, but to state again briefly what we did in our experiments lest certain misapprehensions of Steward and Mühlethaler should lead to more confusion. They say, for example: ". . . and the further advances now being made in the reinvestigation of this plant are due to the superiority of the electron microscope, over X-ray diffraction, for the investigation of such problems as these". This is a narrow outlook, surely; the only hope of real progress in molecular biology lies in co-ordinating the results of every technique available. Elsewhere they say: (*a*) "The X-ray observations, being made upon very short lengths of fibrils . . ."; and (*b*) "In fact the concept of 'poles' almost followed from the method of lines of latitude and longitude by which these authors oriented themselves on the surface of the vesicle studied". As regards (*a*), the ½-mm. X-ray beam, penetrating also the whole thickness of the cell wall, took in, for each diffraction diagram, such greater lengths and greater quantities of fibrils as would require most prolonged exploration in the electron microscope. This, indeed, is one of the chief merits of the X-ray method, that it adds up the situation over a relatively large region and tells us in one go what are the predominating orientations of the better organized cellulose chain-aggregates (that is, the main microfibril directions, as is known from many other X-ray tests—and, incidentally, unaided electron microscope observations stop short of this identification, telling us only that there are microfibrils of so far unresolved structure). Altogether, we must have taken some 1,500 X-ray photographs of different regions and different specimens of *Valonia* cell wall, and we report it as an experimental fact that, though undoubtedly we noted a third orientation from time to time, quite the commonest finding was of *two* principal cellulose chain orientations inclined at rather less than a right angle to each other. Such evidence cannot be dismissed as lightly as Steward and Mühlethaler seem to suggest. A possible way out of the difficulty would be to suppose that there are really three sets of fibrils but that two of them are much more crystalline than the third, which therefore fails to show up properly in an X-ray diffraction diagram; but there is nothing in support of an *ad hoc* discrimination of this kind, particularly in Steward and Mühlethaler's observations and interpretation, and the straightforward and most reasonable conclusion is that the third set, as a rule, is infrequent or simply not there. We ourselves find, in *Valonia ventricosa* and in *V. macrophysa*, that most electron micrographs, too, of the wall fail to reveal any sign of the third orientation; some of

these electron micrographs have been published without comment[4].

Statement (*b*) is unwarranted. Reference to the original paper[1b] will show convincingly that the method of recording the orientations on which we based our model could not possibly have led automatically to the evolution of meridians and the two 'poles'. The 'poles' were located by following religiously one orientation step by step wherever it might lead, and in due course were detected by an unquestionable and dramatic change in the type of X-ray diagram.

We do not doubt that our model will need some modification in the light of the more recent observations; but we see no justification yet for rejecting the older results, which we believe still give in outline a reliable picture of the general run of the more abundant (or more crystalline) microfibrils, whatever the relative importance of the third orientation may turn out to be. It will take an enormous amount of systematic exploration to cover an equivalent range with the electron microscope, and until that has been done it seems to us that comparisons to the discredit of the X-ray data are at least premature.

R. D. Preston
W. T. Astbury

University of Leeds.

[1] (*a*) Astbury, W. T., Marwick, T. C., and Bernal, J. D., *Proc. Roy. Soc.*, B, **109**, 443 (1932). (*b*) Preston, R. D., and Astbury, W. T., *Proc. Roy. Soc.*, B, **122**, 76 (1937).
[2] Wilson, K., *Ann. Bot.*, N.S., **15**, 279 (1951).
[3] Steward, F. C., and Mühlethaler, K., *Ann. Bot.*, N.S., **17**, 295 (1953).
Preston, R. D., Nicolai, E., Reed, R., and Millard, A., *Nature*, **162**, 665 (1948). Preston, R. D., and Kuyper, B., *J. Exp. Bot.*, **2**, 247 (1951). Preston, R. D., Nicolai, E. and Kuyper, B., *J. Exp. Bot.*, **4**, 40 (1953).

In making comment upon our paper on the above subject[1], Profs. Preston and Astbury[3] focus all their attention upon one point, namely, whether the number and orientation of fibrillar directions in the cellulose lamellæ are exactly as they portrayed from X-ray diffraction studies made some long time ago. It will require reference to our paper to make clear that its chief importance arises from the following.

(1) For the electron microscope studies we had access to copious supplies of material freshly collected and kept alive so that preparations made for the electron microscopy could be fixed and made with the minimum of disturbance of the specimen due to drying of the wall, long exposure of it to air or long exposure of the dead vesicle to solutions containing preservatives.

(2) By the use of a special technique—the formation of minute aplanospores which can be cultivated into *Valonia* plants—we were able to trace the sequence of changes that occur as a cellulose wall forms *de novo* on a naked protoplasmic surface. Thus, we were able to obtain, for the first time, a visual picture of how the wall develops.

(3) In the investigation of the wall, we were also able, by the use of sections cut normally to its surface, to study its appearance in both section and in surface view.

(4) While a large part of the work was carried out on *V. ventricosa*, it was also extended to *V. macrophysa*, *V. ocellata* and to another genus in the Valoniaceae, namely, *Dictyospaeria*.

From this new evidence, some interesting facts emerge. First, the new wall at an aplanospore surface develops with great rapidity. The first formed wall consists of a tangled weft of randomly oriented cellulose fibrils embedded in a matrix of material which is not cellulose. Very quickly, however, as the sporeling grows, the random distribution of these fibrils gives place to greater order, parallelism becomes increasingly evident and, in a surprisingly short time from the original formation of the spore as a separate entity, it has cellulose lamellæ with the parallel fibrils running in more than one direction. The electron microscope pictures reveal the more mature wall of *V. ventricosa* as being commonly composed of successive lamellæ with quite strongly oriented strands which cross at an approximate angle of 120°. The appearance of the wall in the cross-section, which we have observed for the first time, is consistent with an interpretation in which the strand directions tend to be repeated in the first, fourth, seventh, etc., layers of wall as they are formed. (It should be mentioned here that one cannot distinguish structure along the length of the cellulose fibrils and, therefore, one cannot tell the *direction* in which the fibrils run. Therefore, one cannot distinguish between three shifts at 60° which would bring the strands back into parallelism with their first orientation, but have them now running in the opposite direction, from three shifts at 120°, which not only restores the strands to parallelism with their first position, but also leaves them still running in the same direction.)

If we read Preston and Astbury aright, they begin by admitting that a "third microfibril orientation may be more frequent than was indicated by our earlier X-ray investigations" (par. 2 in the communication above). The rest of their communication, however, seems designed to justify the original interpretation and does not admit of the possibility that the earlier conclusions can now be modified in the light of later evidence.

The position to us seems to be as follows. In work of this sort it is important to try to preserve the biological structure as far as possible in its natural state. The effects of long drying that may have accompanied the use of a herbarium specimen are not lightly to be ignored. Indeed, at the time of their first writing, Preston and Astbury seem to admit this as a factor contributory to the orientation of cellulose fibrils in directions approximately at right angles to each other. They referred then to the work of Sisson, and say, "Sisson concludes that in general wherever a sample is constricted in one direction, whether by drying or by pressure, then the cellulose crystallites have an inherent tendency to set themselves with the planes of spacing 6·1 A. normal to the direction of constriction. It would appear, therefore, that to explain in *Valonia*—or in any cellulose wall for that matter—the observed selective orientation of the crystallites, about their long direction, it is probably unnecessary to invoke anything more complicated than the simple act of drying". From this it would seem not unreasonable to suggest that a herbarium specimen which had been dried and reinflated might have been subjected to more deformation than was at first supposed. We endeavoured to minimize both the effects of drying and the effects of long storage in solutions in which the wall may be partially macerated.

It also seems to us that Preston and Astbury were more willing in their original paper to recognize the difficulties and limitations of their original method than now seems to be the case. On p. 83 we read, "We have therefore a wall consisting of microscopic-

ally visible layers and corresponding to a network of cellulose chains making an angle of some 80° with each other. Complete understanding of such a structure is obviously impossible without an investigation of that of the *individual layers*—to decide whether even the finest layer has a structure similar to that of the whole wall. . . ." The developmental study which we have made does just this, and it shows, moreover, how the first and the successive layers are laid down.

Preston and Astbury still seem to insist upon their original evidence for one set of cellulose lamellæ in which the fibrils consist of a set of meridians. The arduous technique which leads to this conclusion was apparently carried out only upon one vesicle. Even so, the angles at which the chain directions crossed varied quite considerably at different parts of the wall and it seems that it would require more strict evidence to postulate a preferred direction as absolute as the system of meridians requires—evidence that should relate to more than one vesicle. Also, the evidence for the supposed poles seems not so convincing now as it might earlier have seemed to be. The areas in question gave an X-ray diagram which suggests disorder and random orientation, and this effect, through the whole thickness of the wall, might have arisen in other ways than the one suggested.

It is clear that the results of X-ray examination and of electron microscope studies of the same specimen should be compatible. It is granted that the X-ray method, and prominently so in the hands of Preston and Astbury, has yielded most valuable results. It is, however, still based on observations that have to be made over a relatively short length, which have to be extended over the wall surface as a whole, and it requires interpretations that are obviously complicated when dealing with a system composed of many successive layers each with its own fibrillar direction. Obviously what one does with the electron microscope is not to photograph one field but many such. The degree of integration which is obtained by the X-ray method, because it summarizes events over a given length, is obtained at least in part with the electron microscope by the taking of many pictures on many specimens and deciding from a very large number what is a typical condition and sequence of events. The electron microscope has, however, the great advantage that in each such field investigated the picture revealed has a degree of definition and precision that is not inherent in the X-ray method, which must average in each observation over a considerable area and many layers. Whereas in the electron microscope the several layers can be seen in sharp focus and the strand directions clearly discerned, the X-ray method only reveals this after interpretations that require to be made, and these, as is now evident, are subject to some uncertainty. For example, Preston and Astbury now suggest that the apparent prevalence of two layers in their work instead of three could be accounted for if one of these failed to show properly because two of them are more crystalline than the third. This is just the kind of problem that makes a survey of this sort difficult by the X-ray method, whereas the electron microscope seems to lead more directly to precision.

We can agree with Profs. Preston and Astbury that this, like any other problem of biology, admits of further study. Our purpose was to stress, however, that in these problems of molecular biology it is not enough to study the mature structure. A complete understanding must comprehend how the structure or organism grows and develops and, in achieving this, there is no substitute for the use in the investigation of the living material under such conditions that the changes that occur during growth can be observed. The application of this point of view to the problem of the *Valonia* wall has produced knowledge that did not arise from Preston's and Astbury's earlier work. This does not mean that the earlier results are to be rejected. It does mean, however, that knowledge grows by new observations, by the application of other techniques and by the different approaches that may be adopted by other investigators. It would be surprising and somewhat depressing, indeed, if sixteen years after the first major examination of the *Valonia* wall, made primarily upon a single vesicle, that this did not prove to be so.

In our view, the really challenging problems that these organisms still present are the following. What is the enzymatic machinery which permits the naked protoplasmic surface of the aplanospore so rapidly to build up cellulose in the manner that has now been described ? What is the carbohydrate substrate that is utilized ? What are the forces that control the first shift from randomly oriented fibrils to such strongly oriented parallel directions ? Having once achieved order in the first direction, what induces the organism to lay down its fibrils in the successive directions which seem to be required ? Even though there may be room for some difference of opinion concerning the minutiæ of the structure of the mature wall, these great problems still present their challenge and the way seems now open for them to be attacked.

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ZONE ELECTROPHORESIS OF MUSCLE EXTRACTS: SEPARATION OF PHOSPHOCREATINE, CREATINE, BETA-ALANINE PEPTIDES, AND NUCLEOTIDES

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IN the work reported here, the technique of electrophoresis in liquids supported by solid media has been applied to the separation of a number of non-protein nitrogenous constituents of mammalian muscle. The most important of these can be located on the supporting medium by ultraviolet fluorescence and can then be eluted for quantitative determination or for preparative purposes and purification. This affords a more specific and convenient method for analysis and isolation of some of the compounds studied than has hitherto been available.

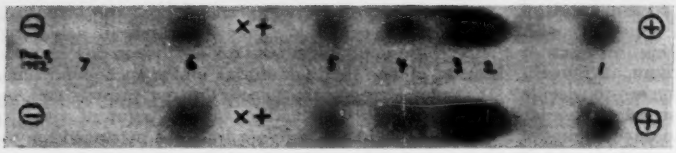

Fig. 1. Detection of rabbit muscle constituents by ultra-violet fluorescence after electrophoretic separation on filter paper.

0·7 μl. (upper half) and 1·0 μl. (lower half) of neutralized muscle extract deposited at +. Spots marked × are starting points corrected for electro-osmosis. 165 min. electrophoresis at 25° C. and 10 V./cm. in sodium succinate buffer – sodium chloride of *p*H 5·6 and μ 0·45.

1, phosphocreatine (as creatinine); 2 and 3, positions assigned to adenosine tri- and diphosphate, respectively; 4, adenosine monophosphate; 5, oxidized diphosphopyridine nucleotide; 6, creatine (as creatinine); 7, anserine and carnosine. Distance between centres of spots 1 and 5 corresponds to 90 mm.

Photograph taken with two 'Mineralight' lamps (2½ hr. exposure) and two 'Philora' lamps (5 min. exposure), all approximately 40 cm. from the filter paper. *F* = 22; Ilford Rapid Panchromatic plate, shielded from ultra-violet rays by Wratten *G* filter and 15-mm. mirror glass plate

The usual procedure in the present experiments was briefly as follows: Cold perchloric acid extracts of fresh skeletal and cardiac muscle were neutralized and concentrated to a volume corresponding to 40 gm. muscle per ml. For electrophoresis, 0·1–2 μl. was placed on or near the centre axis of an 8-cm. wide sheet of Munktell 20 filter paper; up to 250 μl. was used per 100 c.c. of Whatman cellulose powder saturated with buffer medium and packed tightly into an elongated 'Perspex' frame. The electrophoreses were carried out at potential gradients of 10 volts per cm. (filter paper) or about 3½ volts per cm. (cellulose powder) in the apparatus and with the precautions described by Kunkel and Tiselius[1], the filter paper being held tightly between two silicone-treated glass plates. The current ranged from 2 to 50 m.amp. Cooling and temperature control, when desired, were achieved by letting the lower of the two glass plates surrounding the filter paper rest on a large metal block, partly immersed in a water-bath of the proper temperature and by covering the upper glass plate with a metal trough filled with water of the same temperature. The duration of the electrophoresis runs on filter paper was ½–3 hr.; the cellulose powder experiments were run over-night. At the end of the runs the paper sheets, serving as supporting medium, and strips of paper pressed briefly against the surface of the cellulose powder packs, were dried in an air-stream at room temperature and inspected in ultra-violet light of around 254 mμ ('Mineralight' lamp of U. V. Products, Inc.). This served to reveal dark zones or spots on the fluorescent paper, due to adenine and hypoxanthine derivatives[2,3] and to preformed creatinine. The papers were then heated for a few minutes in a dry atmosphere at 120° C. for conversion of the non-visible phosphocreatine and creatine into creatinine. The heating also caused the appearance or intensification of light blue fluorescence due to anserine and carnosine, and possibly other peptides. It also gave rise to yellowish-white fluorescence, due to the presence of glucose[4], which was used as reference substance for estimating electro-osmosis, and of substances in the extracts, possibly also sugars (cf. below). This fluorescence was more intense in ultra-violet radiation of higher wave-length, such as that emitted by the Philips 'Philora' lamp.

A good example of the appearance in ultra-violet light of the centre portion of a dried and heated filter paper sheet after electrophoresis of an extract of skeletal muscle is furnished by the photograph reproduced in Fig. 1. This experiment was carried out at an estimated temperature of 25° C. in 0·175 *M* succinate buffer of *p*H 5·6, brought to ionic strength 0·45, by addition of sodium chloride. As can be seen from the photograph, satisfactory resolution of several of the ions studied was achieved. It was important at the *p*H employed and at the relatively high ionic strength and the resulting high current (28–30 m.amp.) to prevent heating in the paper in order to avoid decomposition of the highly acid-labile phosphocreatine. As is to be expected, this compound moves toward the anode at a high speed (spot 1 in the photograph). In addition to showing up as a dark spot in ultra-violet light, it could be revealed on the heated filter paper as creatinine by spraying with alkaline picrate[5], and as phosphate by treatment with acid molybdate reagent and hydrogen sulphide[6]. Further identification and quantitative analysis were afforded, following elution from the paper and treatment intended to convert phosphocreatine into creatinine, by the characteristic ultra-violet absorption curves and maxima of the latter compound[7]. Quantitative determination as the phosphate was not feasible because of insufficient separation at the *p*H's employed from free orthophosphate. The paper-chromatographic behaviour[8] of the eluate from the area occupied by spot 1 on the unheated paper served as a further check on the identity of the eluted substance with phosphocreatine.

The spots at positions 2, 3 and 4 in Fig. 1 have been assigned to adenosine triphosphate, adenosine diphosphate, and adenosine monophosphate, respectively, on the basis of evidence provided by the ultra-violet absorption spectra of the eluates, by tests for acid-labile phosphate groups, and by comparison with authentic samples with respect to speed of migration in the electric field at various hydrogen-ion concentrations. Due mainly to the choice of a not very favourable *p*H and to the large amount of adenosine triphosphate present, this compound did not separate from the diphosphate in the experiment shown. As has been reported by other authors[9,10], separation of the adenosine phosphates by electrophoresis is best undertaken at *p*H 3·7–4. Hypoxanthine derivatives were not seen in significant quantities in extracts of fresh skeletal and cardiac muscle, but were found to prevail in cardiac muscle excised ½–1 hr. after death of the animal (calf). Similar observations were made during analyses of extracts of brain and of the conductive tissue of the heart. The acid-extractable nucleotide content of the latter tissue was found to be only about one-fourth that of ventricular muscle.

The substance responsible for spot 5 in Fig. 1 was identified as oxidized diphosphopyridine nucleotide. A larger amount of this substance was prepared from the corresponding zone in the cellulose powder pack. The material isolated exhibited an absorption maximum in the ultra-violet at 260 mμ. Electrophoreses carried out with this material in the *p*H range 3·8–9·2 suggested that one was dealing with

an anion having about the size of a dinucleotide and carrying an average net charge not higher than unity. Its speed of migration toward the anode in this *p*H range was therefore compared with that of authentic diphosphopyridine nucleotide, and was found to be the same. Like the latter compound, the zone 5 substance was split by standing in 0·5 *N* sodium hydroxide for 15 hr. at 37° C. chiefly into adenosine-5-phosphate and a moiety which, judging from its electrophoretic properties, is probably nicotinamide mononucleotide. Contrary to what might be expected from the report of Schlenck, von Euler and co-workers[11], nicotinamide and its riboside are not major products of this alkali treatment. Appearance of an absorption maximum at 340 mμ on reduction with sodium hydrosulphite[12,13] of the material eluted from zone 5 left little doubt as to the presence of diphosphopyridine nucleotide. Significant amounts of other substances containing nitrogen, ribose, or phosphate were not present in the eluate. In unfractionated perchloric acid extracts of calf heart muscle that has been contracting partly anaerobically for about one minute, oxidized diphosphopyridine nucleotide accounts, at *p*H 2, for 5–8 per cent of the absorption at 260 mμ, which is the absorption maximum of adenine and nicotinamide. In fresh rabbit skeletal muscle the corresponding percentage is lower.

Spot 6 in Fig. 1 was found to be due to creatinine formed from creatine by heating the filter paper, as evidenced by positive colour reactions on spraying the unheated and heated papers with α-naphthol-diacetyl[14] and alkaline picrate[5] reagents, respectively. The eluate from the unheated paper behaved like a solution of authentic creatine with respect to R_F values[15] and ultra-violet absorption[7,16], both before and after treatment designed to transform creatine into creatinine. Another test for creatinine given by spot 6 and also by spot 1, after electrophoresis in 0·05 *M* potassium phosphate buffer of *p*H 5·9, was the appearance of a yellowish-green fluorescence following application of butyric acid at high temperatures[17]. For some unknown reason, creatine present in and added to the muscle extracts migrated with a greater velocity towards the cathode than creatine applied separately, which at *p*H 5·6 is almost stationary.

Anserine and carnosine were identified as the components of fluorescent spot 7. The fluorescent material moved in the electric field with the same velocity as the authentic peptides. Carnosine was revealed on the paper as an intense red stain after spraying with alkaline diazobenzenesulphonate[18], while spraying with ninhydrin followed by heating produced a green coloration[19]. The eluate from the spot gave the same R_F values on the paper chromatogram as the authentic peptides[19,20], and yielded an ultra-violet absorption curve characteristic of imidazole compounds[21,22]. (Using a Hilger 'Uvispek' photoelectric spectrophotometer we find the absorption maximum of L(+)-carnosine to lie at a somewhat lower wave-length than was reported by de Gouveia *et al.*[23], namely, at 212 mμ (ε = 6,600), both at *p*H 3 and 11.) Because carnosine and anserine differ only slightly with respect to size, shape and ionization (see ref. 23), electrophoresis offers little chance for separating these compounds from each other. However, it makes possible their rapid separation from the bulk of the other muscle constituents.

The unmarked spots in Fig. 1 have not yet been identified. The bright fluorescent spot situated close behind phosphocreatine gave a positive reaction with the aniline hydrogen phthalate reagent[24], which suggests that the rapidly moving anion may be a phosphorylated sugar. Spraying of the filter paper with ninhydrin revealed, in addition to carnosine and anserine, a number of other ninhydrin-positive compounds present in appreciable amounts. Two of these, for which the heart of new-born animals is a good source, appear to be phosphorylated. This phase of the present work is not yet completed.

In some experiments, such as that represented in Fig. 1, requirements for determination of mobilities on paper were, in the main, fulfilled. Thus, evaporation of water from the liquid medium was held at a minimum, electro-osmosis was estimated, and other factors tending to disturb migration in the electric field, particularly adsorption of the ions under study on the paper, were taken into consideration. Making allowance for the electro-osmotic flow and for a 15–25 per cent retardation in the movement of the nucleotides, due to adsorption, and applying the correction factor of Kunkel and Tiselius[1] for non-linearity of the path of ionic migration through Munktell 20 filter paper, the following mobilities of some of the ions studied are obtained, at *p*H 5·6, ionic strength 0·45 and 25° C.: phosphocreatine, $-20{\cdot}6 \times 10^{-5}$; carnosine, $8{\cdot}8 \times 10^{-5}$; oxidized diphosphopyridine nucleotide, $-6{\cdot}4 \times 10^{-5}$; adenosine monophosphate, $-11{\cdot}5 \times 10^{-5}$; and adenosine triphosphate, $-17{\cdot}7 \times 10^{-5}$ cm.^{2} volt^{-1} sec.$^{-1}$. Mobility values for adenosine mono- and triphosphates calculated from filter paper experiments undertaken at ionic strength 0·1 and 0° C. were found to agree quite well with values[16] obtained under these conditions in free electrophoresis.

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LETTERS TO THE EDITORS

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Internal Structure in Virus Particles

Previous electron microscopic studies of chick embryo chorioallantoic membranes infected with herpes simplex virus have revealed that the development of virus in susceptible (ectodermal) cells apparently begins in the nucleus and is completed in the cytoplasm[1]. In the nucleus, the smallest particles considered to be virus measured 40–60 mμ in diameter and the largest did not exceed 130 mμ in diameter. Larger particles, some having a maximum linear dimension of 250 mμ, were seen in the cytoplasm or in extracellular locations. These observations were made on thin sections of tissue from which the methyl methacrylate had been dissolved by amyl acetate.

More recently, particles thought to be transected herpes simplex virus have been seen in ultra-thin sections of infected chorioallantoic membrane from which the embedding substance was not removed. Within the nuclei of cells the virus appeared to consist of a central, spherical body (40–60 mμ in diameter) of varying density, often surrounded by a single membrane (70–130 mμ in diameter), as illustrated in Fig. 1. Within the cytoplasm the particles were generally larger than 130 mμ in diameter and usually possessed a double membrane, as illustrated in Fig. 2. The membranes were separated from each other and from the central body by zones of lesser density. It thus seems reasonable to infer that herpes simplex virus has a definitive inner structure which may be related to its cycle of development within the cell. In this connexion, attention may be directed to the hypothesis of viral structure advanced by Pollard from purely theoretical considerations[2]. The observations reported here tend to support his concept of a central body and an inner zone or membrane in the mature or complete viral particle.

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Since submitting the above communication, which deals only with the virus of herpes simplex, an internal structure has been observed in both vaccinia and influenza virus. In vaccinia virus a body strikingly similar to a cell nucleus may be seen; the structure of influenza virus more closely resembles that of herpes simplex virus. These observations are being extended.

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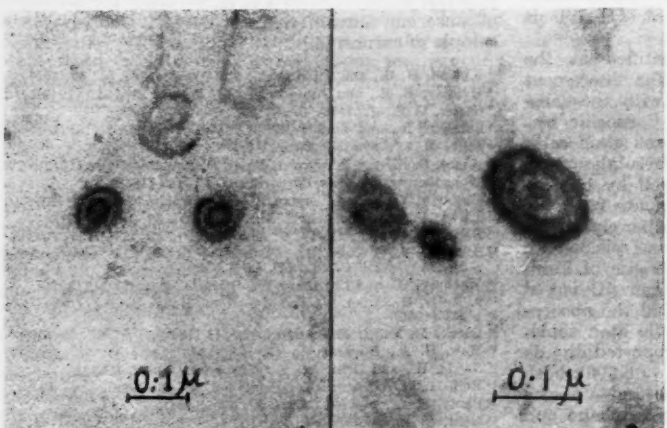

Fig. 1. Two intranuclear particles showing central bodies and single outer membranes
Fig. 2. A particle in the cytoplasm showing the characteristic double outer membrane and central body

A Method for the Rapid Differentiation of Certain Non-pathogenic, Asporogenous Bacilli

It is the experience of most microbiologists that the differentiation of the non-pathogenic, asporogenous, non-pigmented rods is of considerable difficulty. These bacilli form an appreciable part of the air–soil–water microflora and, in materials from marine environments, such as fish, in which our interests are focused, they comprise 60–80 per cent of the total number of species isolated[1]. The main difficulty is that, by the usual tests, most of these micro-organisms appear to be biochemically inert, and the classification, based on a series of negative characters, is not very determinative. The types of organism we have in mind are usually classified among the Pseudomonadaceae, Achromobacteriaceae and Bacteriaceae of Bergey[2] and Prévot[3]. In Bergey, the Pseudomonadaceae comprises, among others, the genera *Pseudomonas*, *Vibrio* and *Spirilla*, and the Achromobacteriaceae the genera *Achromobacter* and *Flavobacterium*. In Prévot, however, the *Vibrios* are removed from the Pseudomonadaceae and form a genus of the Spirillales, while the *Achromobacter* and *Flavobacterium* become genera of the Pseudomonadaceae. Comparison with a recent Russian determinative system[4] shows even wider divergences, the Achromobacteriaceae disappearing altogether, being grouped as *Bacterium* spp. under the Bacteriaceae.

A good example of the present difficulties is the differentiation between the *Pseudomonas* and *Vibrio* spp. According to Bergey, the former are more or less straight rods, usually forming a diffusible pigment, whereas the latter are usually curved rods with no pigment production. In practice, this

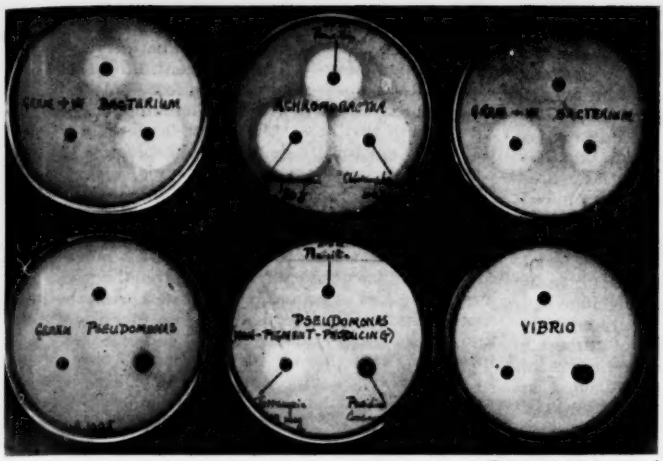

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Table 1

Type of organism	Inhibiting agent		
	Penicillin (2·5 I.U.)	Terramycin (10 γ)	Vibriostatic compound *O*/129* (sat. aqueous sol.)
Pigment-producing *Pseudomonas*	−†	−	−
Non-pigment-producing *Pseudomonas*	−	+	−
Vibrios	−	+	+

* 2-4 Diamino 6-7 di-*iso*propyl pteridine. † −, insensitive; +, sensitive.

the other hand, all the *Vibrios* so far tested react to both terramycin and the vibriostatic agent. Indeed, many of the types from fish, provisionally classified as *Pseudomonas* spp., now appear by this test to be *Vibrios*. The remaining group of *Pseudomonas* spp., which grow somewhat slowly and never form pigment under any conditions so far tested, can also be distinguished by their sensitivity to terramycin (Table 1). Admittedly the total number of strains tested has been relatively small (about two hundred) and future work may well reveal many exceptions. It is considered, however, that such a scheme may well surmount the difficulties of identifying non-pigmented strains of *Pseudomonas* spp. from clinical material, mentioned recently by Gaby and Free[7].

An extension of this work to the other groups of asporogenous non-pigmented rods has resulted in a sensitivity scheme which, together with morphology, reaction to Gram's stain, etc., can quickly differentiate between the main groups of *Pseudomonas*, *Achromobacter* and *Bacterium* (Table 2 and Fig. 1). This provisional scheme has been found particularly useful in the preliminary screening and grouping of several hundred primary isolates from fresh fish[8], and other workers faced with similar problems may find that some such scheme could be adapted to their own field. Further work with other species both from

Table 2

Type of organism	Inhibiting agent			Motility
	Penicillin (2·5 I.U.)	Streptomycin (80 γ)	Chloramphenicol (100 γ)	
Pseudomonadaceæ	−*	+	+ or ++	+ve (polar flagella)
Achromobacteriaceæ	+	++	++	Mainly −ve or +ve (peritrichous flagella)
Bacteriaceæ Gram +ve	+	−	+	+ve (peritrichous flagella)
Bacteriaceæ Gram −ve	−	+	+	or −ve

* −, Insensitive; +, sensitive; ++, very markedly sensitive.

differentiation is not easy, and is never satisfactory, more particularly as many *Pseudomonas* spp. lose the property of forming pigment on continued subculture and some never appear to have possessed it.

In some work done here in 1949 with the help of Dr. N. Reynolds, now of the Ministry of Agriculture and Fisheries Laboratory, Conway, on the effect of certain antibiotics on a variety of bacteria isolated from marine fish, it was noted that the types provisionally classified as *Pseudomonas* spp. could be divided into two clearly differentiated groups. Further work, which has included the use of certain vibriostatic agents[5,6], has now resulted in a scheme for the differentiation of the Pseudomonadaceae of Bergey, which it is thought might be of interest to others in this field. The method employs the normal sensitivity test for antibiotics, using antibiotic tablets, or in the case of the vibriostatic agent, a saturated aqueous solution in an assay cup.

All pigment-producing pseudomonads so far studied from a variety of sources, even although they may have lost the power of pigment production on subsequent subculturing, have been found to be insensitive to the antibiotics and the vibriostatic agent at the concentrations listed in Table 1. On marine and terrestrial sources is proceeding. A full account will be published elsewhere.

We are indebted to Dr. H. O. J. Collier, Pharmacology Department, Allen and Hanburys, Ltd., Ware, Herts, for the gift of a generous sample of the vibriostatic agent.

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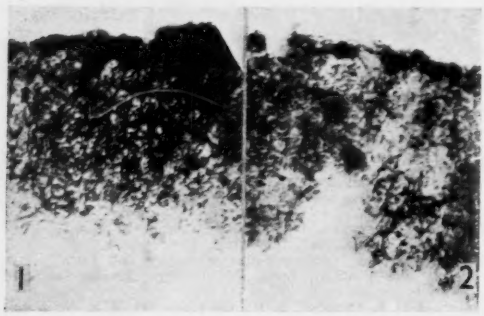
Effect of Experimental Tuberculosis on the Distribution of Alkaline Phosphatase in the Adrenal Cortex of the Guinea Pig

It has been reported earlier that stressor agents like epinephrine[1] and adrenocorticotrophic hormone[2] cause a loss of alkaline phosphatase activity from the adrenal cortex. Administration of serum gonadotrophin to epinephrine-treated pigeons partially prevents this enzymatic loss[1]. The present communication records an attempt to determine whether a comparable reduction in alkaline phosphatase activity occurs in the adrenal cortex in response to a bacterial infection stress.

Twelve male guinea pigs weighing on an average 520 gm. were used in this work. Six animals were injected subcutaneously with a human strain of tubercle bacilli (*H37RV*) of tested virulence, in a dosage of 1 mgm. (wet weight of the inoculum emulsified in 1 c.c. of 0·9 per cent physiological saline solution) per animal. The inoculated animals were killed after eight weeks and post-mortem findings revealed extensive tubercular lesions with caseation in the lungs, liver, spleen and the lymphatic glands. The control animals were injected with 1 c.c. of physiological saline solution in a similar manner and were killed along with the infected animals. Prior to killing, all the control animals were tested with tuberculin and were found to give a negative reaction. The adrenals were carefully dissected out and processed according to the technique of Gomori[3] for the demonstration of alkaline phosphatase.

In the control guinea pigs, the glomerular zone exhibits intense phosphatase activity. The entire area appears as a dark band and the contours of the parenchymal cells are totally obscured by granular deposits of cobalt sulphide (Fig. 1). In the outer fasciculata the nucleus of the parenchymal cells reacts in a strong positive manner; but the distribution of the enzyme is somewhat diffuse in the cytoplasm. The endothelium of the vascular sinusoids of this area, however, shows pronounced phosphatase activity. In the inner fasciculata and the reticularis, on the other hand, the parenchymal cells are virtually devoid of enzyme activity. This is also the case with the endothelium of the vascular sinusoids of these areas.

Macroscopically, the adrenals of the infected guinea pigs are considerably enlarged in size; this could be ascribed mainly to the hypertrophy of the cellular parenchyma of the fascicular zone. The glomerulosa shows no histological response to tubercular infection, and no pathological changes could be detected in any part of the cortex. Cytochemically, a pronounced loss of phosphatase activity is clearly evident upon microscopical examination. In the outer fasciculata the parenchymal cells react only in a faint manner, and similarly the endothelium of the vascular sinusoids of this area. The inner fasciculata and the reticularis are totally devoid of phosphatase activity. Considerable amounts of the enzyme, however, are retained in the glomerular zone (Fig. 2).



Photomicrographs of sections through the adrenal cortex of (1) a normal guinea pig; (2) guinea pig infected with tuberculosis. Note reduction of staining reaction. × 80

It is therefore evident that the above findings agree with previous work[1,2] and indicate that in a bacterial infection stress also there is marked loss of phosphatase activity from the adrenal cortex. The enzymatic loss is probably associated with the rapid metabolism and subsequent decline in critical lipids known to occur during stress conditions. It is interesting that plasma alkaline phosphatase activity in rats shows a comparable reduction in response to adrenocorticotrophic hormone stress[4].

I wish to thank Dr. B. Mukerji for the interest he has taken in this study, and Dr. S. K. Gupta for valuable help.

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Choline Deficiency in the Guinea Pig

The brief report by Reid[1] of the "production of clear-cut deficiencies of . . . choline . . ." in the guinea pig is of considerable interest, as Handler[2] had previously failed to produce fatty livers in guinea pigs maintained on a hypolipotropic diet and had correlated this failure with the low choline oxidase content of guinea pig liver[3]. In view of this discrepancy, we present histochemical evidence here of the centrilobular deposition of fat in the livers of guinea pigs fed a hypolipotropic diet. Such accumulation of fat is characteristic of choline deficiency in the rat[4].

Twenty male guinea pigs of about 550 gm. weight were divided into two similar groups and fed the diet shown in the accompanying table, choline being omitted from the ration of one group. The diets were mixed with some ground chow (Purina Rabbit Chow Checkers, obtained from the Ralston Purina Co., Ltd., Woodstock, Ontario) for the first twelve days, the proportion of the synthetic diet being gradually increased to 100 per cent. The group receiving the choline-supplemented diet was pair-fed on a twice-weekly basis against the deficient group. All animals received oral supplements of ascorbic acid every three or four days. They were maintained on these regimens for as long as 160 days. Some were sacrificed at intervals before this time so that there were only three survivors in the deficient group and six receiving the supplemented diet. The average gains in weight of the longest-surviving animals in these groups were only 112 and 162 gm. respectively.

Frozen sections of the livers were studied with oil red *O*, sudan black *B* and nile blue sulphate. The histochemical findings are illustrated by Figs. 1 and 2. Although a few fat droplets occurred in the

Composition of the Diet

	Per cent		Per cent
Gelatin	1·0	Liver powder	1·0
Casein	2·0	Salt mixture†	4·0
a-Soya protein	5·0	Vitamin mixture‡	2·0
Extracted peanut meal	12·0	Cystine	0·15
Cereograss	7·0	Choline chloride*	0·60
Starch*	10·22	Corn oil	1·0
Dextrin	10·0	Beef fat	4·0
Glucose	20·0	Cod liver oil concentrate§	0·015
Sucrose	20·0	α-Tocopherol acetate	0·010

* In the preparation of the choline-deficient diet, the choline chloride was replaced by an additional 0·6 per cent starch.

† The salt mixture contained the following per kgm.: calcium carbonate, 117 gm.; calcium acid phosphate, 325 gm.; dipotassium phosphate, 275 gm.; magnesium sulphate, 100 gm.; sodium chloride, 150 gm.; iron citrate, 30 gm.; manganese sulphate, 1·985 gm.; zinc sulphate, 0·350 gm.; copper sulphate, 0·400 gm.; potassium iodide, 0·005 gm.; sodium fluoride, 0·005 gm.; potassium alum, 0·040 gm.; cobalt chloride, 0·005 gm.; sodium silicate, 0·20 gm.; and sodium arsenite, 0·010 gm.

‡ The vitamin mixture contained the following per kgm.: biotin, 30 mgm.; thiamine hydrochloride, 500 mgm.; riboflavin, 250 mgm.; pyridoxine hydrochloride, 200 mgm.; calcium pantothenate, 1,000 mgm.; nicotinic acid, 1,000 mgm.; folic acid, 50 mgm.; 2-methyl-1,4-naphthoquinone, 100 mgm.; p-aminobenzoic acid, 10·0 gm.; and sucrose, 987 gm.

§ The cod liver oil concentrate (Ayerst, McKenna and Harrison, Ltd., Montreal, Que.) contained 200,000 I.U. vitamin A and 50,000 I.U. vitamin D per gm.

periportal cells in both groups, only in the choline-deficient animals were there many fine droplets in the centrilobular cells. The liver lipids were not estimated chemically.

That more severe signs of choline deficiency were not observed may have been due to the choice of guinea pigs older than those used by Reid[1] and to their very limited growth during the experimental period. The small gain in weight may be of significance in two respects. First, it would result in a decreased demand for methionine for protein synthesis, labile methyl groups being conserved in this way[5]. Secondly, it suggests that the relatively low caloric intake might have produced a pseudo-lipotropic effect[6]. Such considerations would appear to apply also to Handler's experiments. We would suggest that the difficulty of producing fatty livers in guinea pigs by maintenance on a hypolipotropic diet should not be attributed to the lack of hepatic choline oxidase until it is clear that the difficulty is not simply that of securing a high caloric intake in guinea pigs on an artificial diet.

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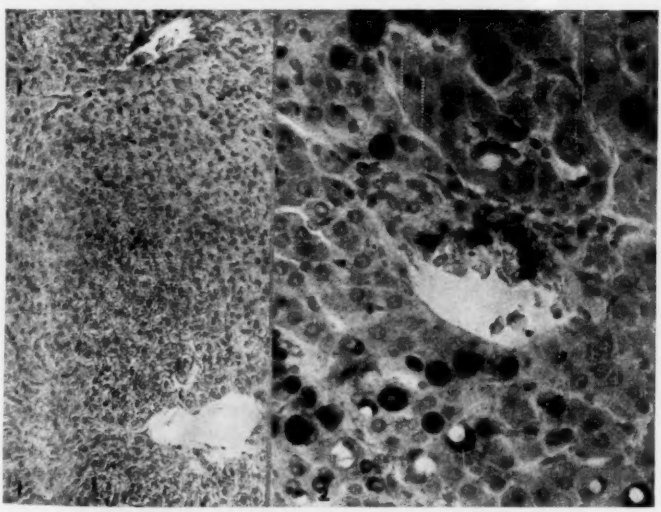

Fig. 1. Liver of guinea pig pair-fed choline-supplemented diet. A few periportal but no centrilobular cells contain fat droplets. × 40

Fig. 2. Liver of guinea pig fed hypolipotropic diet *ad libitum*. Many centrilobular cells contain fat droplets. × 190

Frozen sections of formalin-fixed tissues. Oil red *O*, hæmatoxylin and light green

Steroid Requirements of Housefly Larvæ

It has been known for some time that with very few exceptions[1] insects require only the unsaponifiable, not the saponifiable, fractions of lipids. According to Hobson, for example, the larvæ of *Lucilia sericata* require cholesterol as an extraneous growth factor, and they are capable of synthesizing neutral fat from a lipid-free peptone diet under sterile conditions. Since then, many insects have been found to require a sterol (zoosterol, phytosterol or mycosterol) as growth factor.

This communication describes some preliminary experiments on the specificity of steroids as growth-factors for the housefly (*Musca vicina* Macq.). The experiments, which form part of a more comprehensive study[2], were carried out with larvæ on a diet composed of wheat bran and water (1 : 1), which had been inoculated with a standard bacterial flora (*E. coli*, *Sarcina lutea*, *Lactobacilli* and *Bacillus subtilis*). All experiments were carried out at 35 ± 0·5°, and the weight increase (daily) and pupation time of the larvæ were recorded. It has, of course, been shown[3] that the above bacteria do not synthesize the lipids required by the larvæ. Fig. 1 (p. 212) shows that a lipid-free diet, that is, a diet extracted exhaustively with chloroform (curve *a*), retards the development of the larvæ (both in time and in weight) and practically prevents pupation. Cholesterol or sitosterol (curve *b*) in a quantity of 0·17 per cent (the normal steroid content of the wheat bran used) restores the growth curve to normal: a maximum weight of 22–23 mgm. per larva is reached after four days, and between the fourth and fifth day, 100 per cent

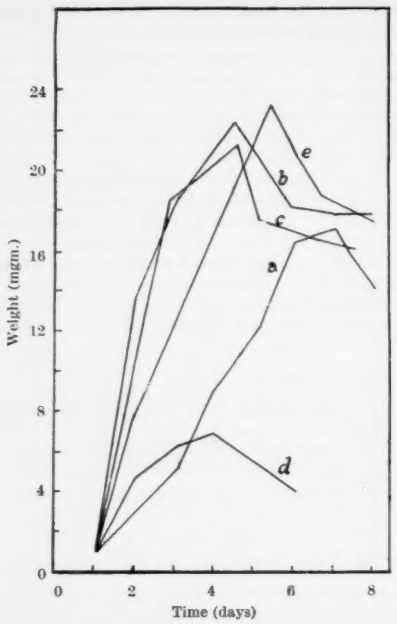

Fig. 1. Growth curves of the pre-adult stages of *Musca vicina* reared on various diets: (*a*) chloroform-extracted wheat bran; (*b*) extracted wheat bran, after addition of 0·17 per cent cholesterol or sitosterol; (*c*) extracted wheat bran, after addition of 0·17 per cent Δ^4-cholesten-3-one; (*d*) extracted or non-extracted wheat bran, after addition of 0·17 per cent cholestan-3-one or cholestan-3-ol; (*e*) control diet

pupation takes place, followed by the normal weight decrease. Δ^4-Cholesten-3-one (curve *c*) has practically the same effect as cholesterol, when applied in a concentration of 0·17 per cent. Cholesterol (and Δ^4-cholesten-3-one) acts, therefore, both as growth and pupation factor; it is essential for pupation.

Very surprising was the effect of cholestan-3-one (curve *d*). It permitted the growth of the larvæ to a weight of about 7 mgm. on the fourth day; then the weight decreased, and on the sixth day the larvæ died. Exactly the same curve was obtained when unextracted wheat bran was used as culture medium and 0·17 per cent of cholestan-3-one was added. Thus the saturated ketone acts as an antimetabolite; its effect appears to be irreversible. Obviously, the larvæ of *Musca vicina* are incapable of dehydrogenating the saturated sterol ring system. This is supported by the observation that cholestan-3-ol has the same effect as cholestan-3-one.

The experiments are being continued with other steroid derivatives and simpler analogous compounds.

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Synthesis of Ribose in Animal Tissues

Recently, we described experiments showing the synthesis of deoxyribose in guinea pig liver extracts by the coupling of a triose with acetaldehyde[1]. The substitution of glycolaldehyde for acetaldehyde as the 2-carbon compound might be expected to lead to the synthesis of ribose instead of its deoxy-derivative, and this has now been shown to occur.

The preparation of the tissues and the general analytical techniques were as previously described[1]. Liver extract was incubated with glycolaldehyde (final concentration 0·08 *M*) together with fructose-1-6-diphosphate (0·02 *M*) as a source of triose; iodoacetate (0·006 *M*) was added to prevent triose breakdown. After incubation, the sugar-phosphate fraction was separated by precipitation with barium acetate and ethanol. Barium was removed from this fraction, and the barium-free solution acted upon by alkaline phosphatase. Analysis by paper chromatography then gave clear evidence of the presence of the two keto-pentoses, xylulose and ribulose, which must initially have been present as phosphate derivatives. These sugars showed all the reactions of authentic samples on the chromatogram, and on elution gave absorption curves with the orcinol reagent showing typical peaks at 670 mμ and 540 mμ. The cysteine–carbazole reaction (see Cohen[2]) was also used in identifying the sugars.

By removing samples from the incubate at different intervals, it could be shown that the formation of xylulose phosphate preceded that of ribulose phosphate (Fig. 1). It seems likely that this reaction, brought about by liver extracts, is the same as that already demonstrated in aldolase preparations of pea seeds by Forrest, Hough and Jones[3], who, starting with the same substrates, were able to identify xylulose and a little ribulose as products of their reaction. Though the synthesis of ribulose phosphate by a mechanism other than the oxidative decarboxylation of hexose derivatives has not previously been reported in animal tissues, our findings agree with those of Glock[4], who has recently shown the accumulation of a ketopentose-1-phosphate (presumed to be xylulose-1-phosphate) when triosephosphate and glycolaldehyde were incubated in the presence of liver fractions. There are also some earlier reports of similar experiments in which pentose was found but not characterized[5].

An additional finding in our experiments was the formation of a ribose phosphate in some of the incubates. Since this pentose, like the two keto-

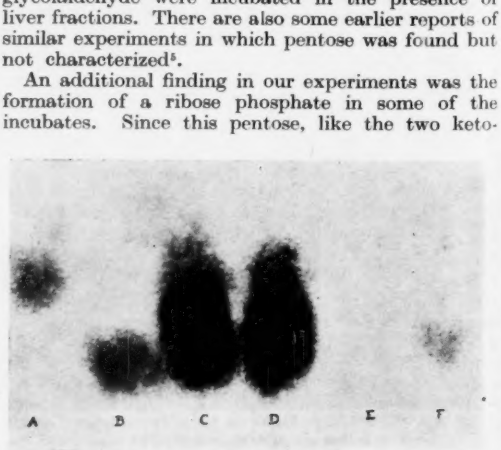

Fig. 1. Development of ketopentoses by the method of Bryson and Mitchell[6]. *A*, ribulose standard (green spot); *B*, 30 min. incubation—xylulose only; *C*, 1 hr. incubation—xylulose and ribulose; *D*, 2 hr. incubation—xylulose and ribulose; *E*, control (no glycolaldehyde)—no ketopentose; *F*, xylulose standard (blue-grey spot)

pentoses, did not appear unless both hexosediphosphate and glycolaldehyde were present as substrates, and then only after the formation of xylulose, it is most unlikely that it was the product of the oxidative decarboxylation of hexose compounds. The evidence suggests that the synthesis was the result of the coupling of dihydroxyacetone phosphate and glycolaldehyde to give xylulose-1-phosphate, and the successive conversion of this compound to a ribulose phosphate and thence to ribose phosphate.

Since liver tissue has been shown to contain a pentose–phosphate isomerase[6], the synthesis of ribose in a system already giving rise to ribulose phosphate might be expected; the conversion is established as an essential step in the formation of ribose by the oxidative decarboxylation of hexose derivatives[7]. The mechanism of the formation of ribulose phosphate from xylulose phosphate, involving an inversion at carbon-3, is less readily explained, though it could be regarded as bearing some analogy to the conversion of glucose to galactose for which a specific waldenase enzyme system exists[8], or to the interconversion of ribulose and arabinose, for which an enediol intermediate has been suggested[2]. It seems clear, however, from these experiments that, contrary to earlier views, ribose—like deoxyribose—can be synthesized in animal tissues by a condensation of 2-carbon and 3-carbon compounds.

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Prosthetic Group of Cytochrome a_2

Cytochrome a_2, which is found in certain bacteria, for example, *Aerobacter aerogenes* and *Azotobacter*, has particular interest as it may play the part of a cytochrome oxidase in these organisms. The main absorption band of this cytochrome in the visible part of the spectrum is in the red region: reduced, 630 mμ; oxidized, 645 mμ; carbon monoxide complex, 635 mμ. Spectroscopic similarities to some ferrophæophorbides[1] as well as to certain bile pigment iron complexes[2] have been observed.

We have now obtained hæmin a_2 free from protohæmin. *A. aerogenes* was cultivated under conditions of vigorous aeration by which the cytochrome a_2 content is increased[3]. The hæmins were extracted with acid-acetone and, after removal of phospholipids, the green hæmin a_2 was separated from protohæmin by precipitation of the latter by benzene.

The acid hæmatin (in glacial acetic acid) has a principal maximum of absorption at 603–5 mμ and a smaller maximum, of one-fifth the height, at 750 mμ. The alkaline hæmatin shows a maximum at 662–64 mμ, the hæm at 618 mμ, and the pyridine hæmochromogen at 613–15 mμ. Cyanide forms a compound with hæmatin a_2 in alkaline solution, causing the disappearance of the band at 662 mμ; on reduction with dithionite, a band appears at 618 mμ. Carbon monoxide also reacts with hæm a_2; the band has the same position as that of the hæm, but is of greater intensity.

By removal of the iron from the hæmin by means of the ferrous acetate–hydrochloric acid or the ferrous formate method a chlorin-like pigment is obtained. Re-introduction of the iron restores the spectrum of hæmatin a_2. In neutral solvents this chlorin has two principal maxima of absorption. In dioxane they are 654 mμ and 503 mμ. Three much weaker bands are found at 597, 572 and 533 mμ. The Soret band has a maximum at 405 mμ. In 10 per cent hydrochloric acid a maximum is shown at 630 mμ. The position of these maxima differs from those of the chlorins, phæophorbides or rhodins, for which data are recorded in the literature.

The 'HCl number' of the free chlorin is close to that of protoporphyrin; but the R_F value of the methyl ester of the chlorin when run on paper chromatograms using the kerosene–chloroform or kerosene–propanol solvents of Chu *et al.*[4] is markedly less than that of protoporphyrin ester.

Lipoid material remains even in the purest preparations. It is possible that, like porphyrin *a* [5], the prosthetic group of cytochrome a_2 possesses a lipophilic side-chain.

When the chlorin and the hæmatin were treated with hydroxylamine by the methods of Lemberg and Falk[6], there was no shift in the position of the band at 652 mμ of the chlorin in pyridine or the band at 615 mμ of the pyridine hæmochromogen. Thus it is unlikely that the side-chains of the prosthetic group possess a formyl or carbonyl group.

The evidence for assuming that this hæmin and chlorin were derived from cytochrome a_2 is as follows. The intensity of the acid hæmatin band at 603 mμ, or of the chlorin band at 652 mμ in acetone, was proportional to that of the cytochrome a_2 band. *Azotobacter vinelandii*, *Escherichia coli* and *Proteus vulgaris*, all known to contain cytochrome a_2, yielded this hæmin and chlorin. When the bacteria were grown anaerobically, neither cytochrome a_2, hæmin a_2, nor chlorin was obtained. Some organisms such as *Bacillus mycoides*, *Bacillus subtilis* and *Pseudomonas aeruginosa* developed relatively small amounts of cytochrome a_2 when grown in liquid medium with vigorous aeration, and correspondingly gave small amounts of this hæmin and chlorin.

We therefore conclude that the isolated hæm and chlorin are the prosthetic group and iron-free prosthetic group, respectively, of cytochrome a_2.

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Cysteine and Phosphoserine containing Peptide Sequences of Ovalbumin

To investigate whether certain amino-acid sequences, for example, cysteinylglycine[1], occur with greater than chance frequency in different proteins[2,3], a method has been devised for the isolation and identification of cysteine containing sequences, and for peptide sequences containing O-phosphoserine, a compound with which at least one of the two phosphorus residues in ovalbumin[4] has now been identified. 2-gm. portions of four times crystallized, performic acid oxidized[2] ovalbumin were precipitated and washed with trichloroacetic acid, hydrolysed with 40 ml. of 11 *N* hydrochloric acid for 3–7 days at 37°, and hydrochloric acid removed *in vacuo* below 25°. A strongly acid peptide fraction was separated from the hydrolysate by washing through a 4 cm. × 10 cm. 'Dowex 50' (H^+ form) column with water, and the effluent was dried *in vacuo*, neutralized in small volume, and applied to a 1 cm. × 50 cm. 'Dowex 2' column (*p*H 3, Cl^- form). Slow elution with 400 ml. hydrochloric acid rising continuously from 0·001 to 0·05 *N* provided fractions containing only one to three peptides, separable by one-dimensional paper chromatography. Composition and N-terminal amino-acid of each peptide were determined by paper chromatography of sealed-capillary hydrolysates (11 *N* hydrochloric acid, at 110°) of aliquots, with and without treatment with dinitrofluorobenzene[5].

Essentially all the strongly acid components of a seven-day hydrolysate have been identified (Table 1); they include eleven dipeptides of cysteic acid (theoretical maximum fourteen, assuming no duplications[6]). Because of its acidity and composition (cf. Perlmann[4]), chromatograms of the one peptide lacking cysteic acid, aspartyl (glutamic acid, serine), were sprayed with the reagent of Hanes *et al.*[7], after marking ninhydrin-positive spots. The presence of phosphorus was readily demonstrated.

Table 1. Peptides identified in a Seven-Day Hydrolysate of Ovalbumin

In order of elution from 'Dowex-2' columns:

cysteyl (alanine, valine)	threonylcysteic acid	cysteic acid
cysteylalanine	valylcysteic acid*	aspartyl (glutamic acid, serine)*
cysteylglycine	cysteylglutamic acid*	cysteylphenylalanine
cysteylvaline	phenylalanylcysteic acid	aspartylcysteic acid
serylcysteic acid	glutamylcysteic acid*	

* Identified in relatively small amounts in only one hydrolysate.

When performic acid oxidation was omitted, most of the peptides passing through the cation exchanger contained phosphorus, and were then easily purified because of their small number. Free phosphoserine was identified by comparison of its R_F and that of its dinitrophenyl derivative in three solvents with corresponding authentic samples (gift of Dr. William H. Summerson), and traces of it were usually also found in hydrolysates of its peptides (Table 2). Since only two dipeptides of phosphoserine were identified, it is likely, though not certain, that they belong to the same sequence, aspartylphosphoserylalanine (aspartylserylphosphoserine and phosphoserylserylalanine would not be expected to survive the partial hydrolysis), and that *iso*leucine and glutamic acid are joined to this sequence, but not directly to phosphoserine. Analyses[8] of an acid hydrolysate of each dipeptide (Table 2) suggest equimolar ratios, considering serine destruction under these conditions.

Table 2. Phosphorus-containing Components from Ovalbumin

	Amounts in micromoles isolated from 1 gm. protein				
	Phosphorus Before hydrolysis	Phosphorus After hydrolysis	Serine	Aspartic acid	Alanine
Phosphoserine	0	0·27	0·25	0·32	1·13
Aspartylphosphoserine	0·03	1·03	0·58		
Phosphoserylalanine					
Aspartyl (glutamic, acid, phosphoserine)*					
Aspartyl (alanine, glutamic acid, *iso*leucine, phosphoserine)					

* Identified in relatively small amounts in only one hydrolysate.

Since C-terminal serine peptides have not previously been found in acid hydrolysates[2,5], the isolation of aspartylphosphoserine from 3- (though not 6-) day hydrochloric acid hydrolysates supports the view that the acid lability of serine–amino peptide bonds is due to N to O acyl migration[9]. The successful application of these methods to ribonuclease[10], and particularly the association of aspartic acid, glutamic acid and *iso*leucine[11], and alanine[12], with phosphoserine in casein, encourage a search for systematically recurring sequences in proteins. This, as well as studies on the role of glutathione as precursor of the cysteinylglycine of ovalbumin, will be reported elsewhere.

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Coproporphyrin Formation in Yeast

In recent articles in *Nature*, Keilin[1] has described the occurrence of hæmoglobin, in very low concentration, in certain strains of bakers' yeast, and Keilin and Tissières[2] have likewise demonstrated the presence of hæmoglobin in the mycelia of the moulds *Neurospora crassa* and *Penicillium notatum*. In the latter investigation, free protohæm was also found, especially in fragments of mycelium undergoing autolysis, following their projection from the aerated nutrient on to the walls of the containing vessel. The free hæm in the moulds appeared to originate from intracellular hæmoglobin and from some components of cytochrome by an enzymic degradation which accom-

panied the autolysis of the mycelium. In old mycelia, the free hæm itself was further degraded with liberation of iron and the formation of free porphyrin. These important findings are particularly relevant to the study of porphyrin formation in autolysing yeast.

Experiments with top-fermentation brewers' yeast have shown considerable increase in yield of porphyrin following treatment with solid ammonium carbonate and glucose[3], to yield coproporphyrin isomers I and III in varying proportion, but with traces only of proto- and deutero-porphyrins. Coproporphyrin in the medium was itself undergoing change, and apparently accumulated owing to the relative rates of formation and removal being out of phase[4]. Exogenous added cytochrome and catalase were destroyed in the yeast preparation, but did not augment the yield of coproporphyrin. From observations on the effects of various chemical agents, it was concluded that coproporphyrin probably did not arise from by-products of fermentation, but possibly as a result of rapid proliferation of the yeast cells, using ammonium carbonate as a ready source of carbon and nitrogen.

Further studies have been made on the relationship of coproporphyrin concentration to other aspects of yeast metabolism, such as respiration, fermentation and cell division. To facilitate sampling, the yeast was diluted with distilled water after it had been subjected to ammonium carbonate – glucose treatment. The addition of water was responsible for much lowered yield of porphyrin.

The results now obtained do not support the earlier view[4] that the yeast cells in the ammonium carbonate – glucose preparation are growing rapidly. An early fall in the total cell count was observed, which may have arisen from the combined effects of restricted oxygen supply to a medium densely packed with cells[5], and of plasmolysis of many cells, causing them to resemble cellular debris, overlooked in counting. The majority of cells enumerated at 21 hr. were granular in appearance. Rates of respiration and fermentation also showed a decline, indicating that the predominating changes in the yeast were autolytic in character. Also, coproporphyrin concentration was independent of the rates of cell division, respiration and fermentation.

The evidence points to formation of coproporphyrin in these yeast preparations, not through excessive synthesis in actively dividing cells, but rather by catabolism of preformed intracellular hæmoproteins in damaged or dead cells, as described in mould mycelium[2]. Although earlier work[4] has shown no conversion of added exogenous cytochrome *c*, catalase or (unpublished observations) human hæmoglobin, this does not exclude such endogenous hæm derivatives as possible sources of porphyrin. Moreover, the frequent occurrence of free hæm in extracts, and the conversion of proto- to coproporphyrin in yeast, lend support to this hypothesis. Addition of protoporphyrin 9 to yeast alone resulted in increased formation of coproporphyrin as shown in Table 1.

Table 1. COPROPORPHYRIN IN YEAST FOLLOWING ADDITION OF PROTOPORPHYRIN 9

1 mgm. protoporphyrin added to 100 gm. top-fermentation brewers' yeast, and coproporphyrin and residual protoporphyrin measured after 24 hr.

Coproporphyrin present (μgm.)		Protoporphyrin recovered (μgm.)
control 100 gm. yeast alone	100 gm. yeast + protoporphyrin	
102	418	72

The increased yield (316 μgm.) of coproporphyrin associated with the disappearance of 928 μgm. protoporphyrin 9 suggests that yeast is able to convert protoporphyrin 9 into coproporphyrin, and the latter could arise from a protohæm derivative.

The events leading to porphyrin formation may be conceived as follows. Cytological damage liberates intracellular hæmoproteins from structures inside the yeast cell, and thus renders these pigments accessible to the action of proteolytic enzymes. Attack upon and digestion of the protein moiety of the hæmoprotein liberates the hæm group, and from this porphyrin is readily derived.

The mode of action of ammonium carbonate and glucose, by which regular, marked facilitation of porphyrin production is achieved, remains for study. Glycine, urea, acetamide, glutamic acid, *d*-glucosamine and asparagine were all without effect. It is clear, however, that porphyrin appears in yeast through processes quite dissimilar from those liberating it during hæmopoiesis in man, in which coproporphyrin forms part of the biosynthetic pathway from glycine to hæmoglobin.

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Human Visual Purple and Absolute Threshold

I HAVE just read the interesting communication by Drs. Crescitelli and Dartnall on human visual purple (rhodopsin)[1]. The last paragraph of that article may give rise to the impression that new evidence has been brought forward, as a result of which the work of Hecht, Shlaer and Pirenne[2] on the minimum number of light quanta necessary for vision might have to be considerably revised. Such an impression would, I think, be mistaken. Crescitelli and Dartnall were able to repeat and confirm König's[3] measurement, made in 1894, of the optical density of the rhodopsin extracted from a human retina. On such a basis König calculated the percentage p of the light incident on the human retina which should be absorbed by the rhodopsin contained in the living rods, and found $p = 4$ per cent for $\lambda = 0{\cdot}51$ μ. Crescitelli and Dartnall now find $p = 3{\cdot}5$ per cent. König's result was quoted and taken fully into account in the above paper by Hecht *et al.* Crescitelli and Dartnall's work, however valuable in other respects, affects but little the outcome of the discussion.

The small difference found by Crescitelli and Dartnall between frog and human rhodopsin is irrelevant with regard to the higher value, $p = 20$ per cent, which Hecht *et al.* chose as a basis for their calculations. It would have tended to increase, rather than to decrease, this value. This cannot be discussed here, but a more important fact is that the 20 per cent value was purposely chosen as an upper limit by Hecht *et al.* Such a limit was required because, when that paper was written, the main

point of interest was to establish that the minimum number n of quanta actually involved in a visual act must be very small, namely, of the order of 10 or less, instead of about 50 as had usually been believed hitherto[4]. Hecht *et al.* wrote: "From the comparison it is apparent that the 5 per cent maximum absorption curve [of rhodopsin] describes the points [of the corrected sensitivity curve] quite well, but that *the* 20 *per cent curve is definitely excluded* because its absorption on both sides is just too high. . . . However, to be quite safe, we may take 20 per cent as the upper limit for the absorption of 510 mμ by the visual purple in the human retina after complete dark adaptation". Now, Crescitelli and Dartnall write: "Their [Hecht *et al.*] figure of 20 per cent absorption by the visual pigment was based on an indirect calculation in which it was implied that the scotopic pigments of frog and man were identical". This is, I think, somewhat misleading.

Crescitelli and Dartnall do not mention the dichroism of the retinal rods which Schmidt[5] observed in 1938. Such dichroism seems likely also to exist in man. If so, even assuming that no losses of rhodopsin occurred in the extraction made by König and by Crescitelli and Dartnall, their values for p may be too low. If losses occurred, the true value of p must be higher still. Another source of uncertainty with regard to the retinal threshold n relates to the transmission of light by the pre-retinal eye media[6]. The problem as a whole is too complicated to be discussed here, but a word may perhaps be added in connexion with Crescitelli and Dartnall's estimate of n, which they suggest is equal to "1–3 quanta approximately". Various indirect methods prove that n is greater than 1; there is general agreement on this point among workers in the field[7]; and there are also strong reasons[8] for believing that n is greater than 2.

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Occurrence of Dieldrin-resistance in Wild *Musca domestica* L. in England

The ability of insects to develop a resistance to an insecticide is now widely acknowledged. It has also been shown that, where resistance to a specific insecticide exists, the toxicity of related compounds can be tolerated also, though probably to a lesser extent. This communication reports the occurrence of a high degree of resistance to dieldrin (an insecticidal product containing not less than 85 per cent of 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8a-octahydro-1,4,5,8-dimethanonaphthalene, and not more than 15 per cent of insecticidally active related compounds), in a wild strain of *Musca domestica* L. which had not been exposed to this insecticide prior to this investigation.

Trials carried out during the past summer to assess the value of dieldrin for the control of the common housefly, *Musca domestica* L., on a refuse tip in Hertfordshire, proved unsuccessful. During the past four years insecticides containing DDT and gamma BHC have been applied to control flies on this refuse tip. The development of a housefly population resistant to DDT and BHC was therefore suspected. The American workers Bruce and Decker[1] have demonstrated by controlled laboratory experiments that BHC-resistant flies show some tolerance to dieldrin. If this wild strain of houseflies was resistant to BHC, the failure of these trials with dieldrin could be explained. The resistance of the wild housefly population to DDT, gamma BHC and dieldrin was therefore investigated.

Houseflies were collected from the refuse tip and reared in the laboratory under standard conditions without further contact with insecticide. The progeny was tested, concurrently with a normal laboratory culture, against technical DDT (80 per cent *p.p'* isomer), BHC (99 per cent gamma isomer) and technical dieldrin (which contains 90–95 per cent dieldrin), formulated as oil sprays. A modification of the direct spray technique described by Kearns and March[2] was used, the insecticides being sprayed at concentrations calculated to give approximately 10–90 per cent mortality in 24 hr. (Table 1). All tests were carried out at 80° F. and 50 per cent relative humidity.

Comparison of the strains for resistance was made on the L.D. 50 (concentration of insecticide required to give 50 per cent mortality) estimated from log–probit regression lines. The resistance of the laboratory strain was taken as 1.

Table 1. Resistance to DDT (80 per cent *p.p'* Isomer), BHC (99 per cent Gamma Isomer) and Dieldrin of a Wild Strain of *Musca domestica* L. collected from a Refuse Tip
Means of at least three replicated tests with oil-based sprays

Insecticide	Strain of *Musca domestica* L.	% Concentration (w/v) of insecticide	Mean % mortality in 24 hr.	L.D. 50 (% concentration)	Relative resistance
Technical DDT	Laboratory	0·05 0·075 0·10 0·125 0·15	22 41 56 66 75	0·09	1
	Wild (third generation)	1·00 1·50 2·00 2·50 3·00	28 45 54 64 73	1·75	19
Gamma BHC	Laboratory	0·0025 0·005 0·0075 0·01	24 48 56 72	0·0055	1
	Wild (fourth generation)	0·10 0·25 0·40 0·50 0·75	12 41 63 72 88	0·29	53
Technical dieldrin	Laboratory	0·0015 0·0025 0·005 0·01	6 20 62 83	0·0045	1
	Wild (third generation)	0·50 0·75 1·00 1·50 1·75 2·50	10 23 43 57 70 86	1·2	266
Pyrethrins	Laboratory	0·1	43	—	—
	Wild	0·1	37	—	—

It was not possible to test each insecticide against the same generation of flies from the wild strain, owing to insufficient numbers being available. Third generation flies were tested for resistance to DDT and dieldrin, and fourth generation flies for resistance to gamma BHC. A check test with dieldrin against the fourth generation of flies indicated that there was no difference in resistance between the third and fourth generations.

Each strain was also tested against the official test insecticide (0·1 per cent w/v pyrethrins), which is the standard prepared by the Chemical Specialities Manufacturers Association, 110 East 42 Street, New York, U.S.A., and used in many countries; 'normal' strains give 30–55 per cent mortality when sprayed with it.

The wild strain of houseflies was found to be 19 times more resistant to DDT, 53 times more resistant to gamma BHC and 266 times more resistant to dieldrin, than the normal laboratory culture (Table 1). Bearing in mind that the wild strain was resistant to gamma BHC, some resistance to dieldrin was anticipated, but the concentration of dieldrin tolerated was surprisingly high in comparison with the normal strain. There appeared to be little difference in resistance to pyrethrins.

The magnitude of dieldrin-resistance shown by the wild housefly population cannot be readily explained, as the insecticide had not been used for fly control on this particular refuse tip before these trials were undertaken.

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Thermo-chemical Seed Treatment

Newhook[1], using the technique of Baylis[2], reported that a hot-water steep of 10 min. at 52·8° C. controlled seed-borne pasmo (*Sphaerella linorum* Wollenw.) in seed-lines of linen-flax (*Linum usitatissimum* L.). Watson *et al.*[3] have recently reported the use of carbon tetrachloride as a suitable material in place of water for heat treatment of peas and beans. It has been shown by them that germination of peas and beans was not affected by a 60-min. steep at 75° C. Heat transfer into the seeds was demonstrated, but very little carbon tetrachloride was absorbed.

Experiments have been carried out to determine the effect of a carbon tetrachloride steep on germination and control of seed-borne pasmo in linseed. Thirty-six temperature – time combinations were studied, ranging from 5 min. to 30 min. with 5 min. variations, and from 50° C. to 75° C. with 5 deg. temperature differences.

Two varieties, namely, Golden Viking and Koto, were treated. 10-gm. lots of seed were steeped in a carbon tetrachloride bath maintained at the different temperature-levels by a Towers thermostatic control unit. Seed was germinated in Petri dishes on moist filter pads in an incubator at 22° C. for seven days. Seed was examined for viability of *S. linorum* (*a*) by the technique of Loughnane *et al.*[4], followed by removal of spores to Van Teigham cells and incubation at 22° C. for 24 hr.; preparations were stained with cotton-blue lacto-phenol, and examined for the presence of germ-tubes; (*b*) by plating surface disinfected seeds on 'Bacto-prune' agar in Petri dishes and incubating at 22° C. for six days.

No mucilaginous sludge developed in the course of treatment, and no carbon tetrachloride appeared to be absorbed. Results of germination counts are presented in the accompanying table. Analysis of these results showed significant depression of germination only at 70° and 75° C. for 30 min. with Golden Viking and 20 min. with Koto. These treatments also markedly reduced vigour of the seedlings, their development being two to three days slower than those of untreated seed.

In the technique used for determining spore germination, no germ-tubes were observed after treatment for 20 min. at 65°, 70°, 75° C. or for 30 min. at 60° C. In the plate tests, no cultures were obtained from seed treated for 15 min. at 70° or 75° C., 20 min. at 65° C. or 30 min. at 60° C. Untreated seed samples yielded 14 per cent infected seed (Fig. 1).

A similar experiment, using linseed infected with browning (*Polyspora lini* Laff.) and the plating technique, has also been carried out. No cultures were obtained from seed treated for 15 min. at 70° C. or 20 min. at 65° C.

From these preliminary experiments it would appear that complete control of two seed-borne diseases of linseed can be obtained by a carbon tetrachloride steep at times and temperatures which do not affect germination.

The use of carbon tetrachloride in place of water as a material for heat-treatment of linseed has two technical advantages over the latter: first, the safety limits with respect to germination are wider; secondly, no artificial drying of seed is necessary. On the other hand, a specially designed steep for elimination of fumes and recovery of carbon tetrachloride given off as a vapour during the treat-

Germination Results of Heat-treated Linseed

Treatment / Time	Mean percentage germination (three samples of 100 seeds) Golden Viking* Temperature 50°	55°	60°	65°	70°	75°	Koto† Temperature 50°	55°	60°	65°	70°	75°
5 min.	82·3	88·0	87·7	83·3	80·7	81·0	98·3	91·0	97·0	90·3	90·0	86·7
10 ,,	74·3	88·3	86·7	82·7	72·7	83·0	91·3	91·3	93·0	92·0	92·0	93·0
15 ,,	82·0	82·3	87·0	86·3	76·3	81·0	93·7	91·0	88·0	89·0	87·0	92·0
20 ,,	82·7	71·3	90·7	76·3	74·0	72·7	97·3	96·3	93·3	84·0	82·0	95·0
25 ,,	86·3	79·0	81·3	81·3	73·3	79 3	90·7	90·7	94·0	91·3	80·3	94·3
30 ,,	83·7	86·3	86·3	88·3	68·3	67·0	89·0	97·3	92·3	85·7	75·7	81·0
Control	79·0						92·0					

* Difference for significance at 5 per cent level = 10·0; at 1 per cent level = 13·4.
† Difference for significance at 5 per cent level = 8·7; at 1 per cent level = 11·5.

Fig. 1. Pasmo-infected seed showing appearance of pycnidia on seed coat after germination in moist chamber. × 7. Photograph by R. C. Blackmore

'ment would be required for the efficient operation of a thermo-chemical treatment plant.

A full account of this work will be published elsewhere. Thanks are due to Miss E. Milne, Applied Mathematics Laboratory, N.Z. Department of Scientific and Industrial Research, for statistical analysis of results.

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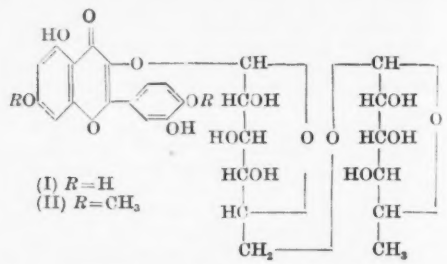
An Antagonist of the Sterility Hormone Rutin in the Green Alga *Chlamydomonas eugametos*: Ombuoside=7.4′-Dimethyl-rutin

Rutin (= quercetin-3-rutinoside) prevents the copulation of male and female gametes in *Chlamydomonas eugametos*[1]. Its effect is very specific. Checking more than forty flavonols, it was found that only rutin induces sterility. The sugar at carbon atom 3 (rutinose) seems to be important, as quercitrin (=quercetin-3-rhamnoside) does not influence fertility.

In 1935 a strain was obtained which could not be made to copulate[2]. Filtrates of these *agametos* cells, like rutin, prevented the copulation of *eugametos* gametes. Thus *agametos* cells produce and secrete a sterility hormone. This hormone could be isolated from cells of a certain *agametos* mutant. It was identified as rutin[3] (I).

Three enzyme systems dependent on genes are responsible for rutin formation in *agametos* cells: (1) the formation of *l*-rhamnose (gene *rha*$^+$), (2) the formation of rutinose from *l*-rhamnose and *d*-glucose (gene *runo*$^+$), (3) the formation of rutin from quercetin and rutinose (gene *ru*$^+$). *Agametos* has *rha*$^+$*runo*$^+$*ru*$^+$, *eugametos* has *rha*^{0}*runo*$^+$*ru*^{0} [4]. Quercetin could be isolated from cells of a *ru*^{0} *agametos* mutant[3], suggesting that the biosynthesis of rutin follows the sequence given above.

However, *agametos* cells become able to copulate when the cells are kept in the dark for three days. Then the cells are practically free of rutin. They lose their ability to copulate after a period of illumination of 15–20 min. During the short period of copulation, it is possible to cross *agametos* with *eugametos*. The effect of rutin is not yet clear. It is evident that the formation or the secretion of gamones which induce the last phase of the copulation is disturbed.



(I) R=H
(II) R=CH$_3$

We have now been able to examine ombuoside (II), a glycoside that is a 7.4′-dimethyl-rutin, which has been obtained from the leaves of the ombu (*Phytolacca dioica*, L.), where it accompanies rutin[5]. The results of the experiments are: (1) ombuoside (10^{-5} gm./ml.) shows no influence on the copulation of *eugametos* gametes; (2) *agametos* cells obtain the ability to copulate in solutions containing 10^{-6} to 10^{-7} gm./ml. ombuoside; (3) *eugametos* gametes made sterile by rutin (10^{-6} gm./ml.) begin to copulate again after adding ombuoside (10^{-6} gm./ml.); (4) *eugametos* gametes continue to copulate in solutions containing ten times more ombuoside than rutin.

We conclude from these results that ombuoside is able to compensate the rutin effect.

We also tested 7.4′-dimethyl-quercetin or ombuin, the aglycone of ombuoside. It has no influence on *eugametos* gametes. However, we found that ombuin compensates the sterility of *agametos* cells. This effect may indicate that *agametos* cells can form ombuoside enzymatically from ombuin.

The specificity of 7.4′-dimethyl-quercetin was demonstrated by examination of ten other methyl derivatives of quercetin (for which we thank Dr. I. Loew, Max Planck-Institut fuer Medizinische Forschung, Heidelberg), namely: 7-, 5-, 3-, 3′-, 7.3-, 3.5.3′-, 3.7.3′-, 5.7.3′-, 5.3′.4′-, and 7.3′.4′-methyl quercetins were without any effect on *agametos* cells. These results show that 7.4′-dimethyl-quercetin (ombuin) and 7.4′-dimethyl-rutin (ombuoside) have a special importance in this antagonism with rutin.

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Distribution of Radio-Frequency Brightness across the Solar Disk and the Derivation of a Model Corona

DETERMINATIONS of the distribution of radio-frequency brightness across the solar disk have been made by Stanier[1] at a wave-length of 60 cm. and by Machin[2] at a wave-length of 3·7 metres. A series of similar observations has been carried out by one of us[3] at wave-lengths of 1·4, 3·7 and 7·9 metres during the period July 1951–July 1952. In this communication we describe the results of an attempt to derive a model of the corona which is consistent with these observations[4].

made about N or T; instead, an attempt was made to derive these quantities directly from the radio observations. The model which was found to fit the observations most closely was given by:

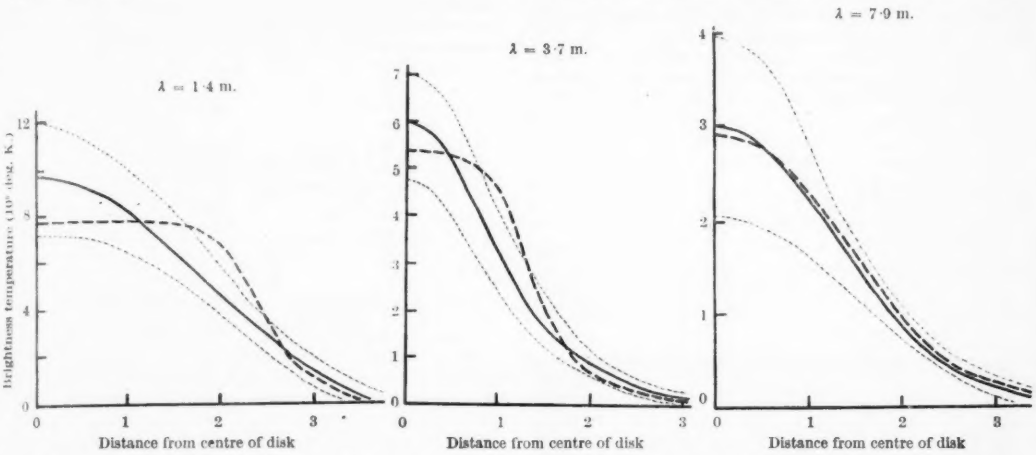
$$N = 1{\cdot}6 \times 10^8 R^{-5} \text{ cm.}^{-3}.$$

$$T = 2 \times 10^6 R^{-2} \text{ deg. K.}$$

over the range $R = 1{\cdot}2\ R_0$ to $3{\cdot}0\ R_0$, where R_0 is the radius of the photosphere.

This distribution of electron density agrees well with that of Allen for small values of R, but for R greater than $2R_0$ the density decreases more slowly outwards.

The extent to which the new model can account for the observations is shown in the graphs. It is


λ = 1·4 m.
λ = 3·7 m.
λ = 7·9 m.
Brightness temperature (10⁶ deg. K.)
Distance from centre of disk
Distance from centre of disk
Distance from centre of disk

Distribution of radio brightness across the solar disk at three wave-lengths. The distance from the centre of the disk is given in terms of the radius of the photosphere (R_0).

——, Experimental curves; ·····, limits within which the experimental curves are believed to fall; – – –, theoretical curves

The experiment showed that the contours of constant radio brightness were roughly elliptical in form and varied slightly from day to day. As a first approximation for the purposes of theoretical interpretation, they were replaced by constant circles. The average radial distributions which were used in this way to represent the experimental results are shown as continuous lines in the accompanying graphs. The uncertainty of the experimental results is indicated by the dotted lines, which show the limits within which the distributions are believed to fall. The limits are predominantly caused by an uncertainty in the absolute scale of brightness (because small errors in the distribution for large radii can introduce large errors in the determination of the central temperature). There is also some uncertainty in the results arising from the day-to-day variations.

Smerd[5] has derived theoretical curves for the distribution of brightness for a number of wave-lengths, assuming the coronal electron density, N, given by Allen[6] and a number of uniform temperatures, T. It is clear from a comparison of the observations with these theoretical curves that a coronal model with uniform temperature cannot account for the observations, and, in particular, that it cannot provide sufficient intensity at large radii.

If the electron density derived by Allen is retained, analysis showed that these discrepancies could not be removed by assuming that the temperature varied with height in the corona. A new method of analysis was therefore adopted in which no assumptions were

seen that a satisfactory fit is obtained for $\rho > 1{\cdot}5\ R_0$ (where ρ is the distance from the centre of the disk), which is the important region where Smerd's curves show the greatest discrepancy with observation. For values of ρ between $0{\cdot}5\ R_0$ and $1{\cdot}5\ R_0$ the intensity at 1·4 and 3·7 metres is somewhat greater than that observed. It seems likely, however, that this remaining discrepancy may be removed when it has been possible to allow for the effects of scattering by irregularities of electron density in the corona. Some information about these irregularities for $R > 5\ R_0$ has recently been obtained by Hewish[7] from observations of the occultation by the solar corona of the intense radio source in Taurus. It is possible that the inclusion of the scattering effects in the analysis may result in some modification to the values of N and T derived above.

This work was carried out as part of a programme of radio research at the Cavendish Laboratory, supported by the Department of Scientific and Industrial Research.

P. A. O'BRIEN
C. J. BELL

Cavendish Laboratory,
Cambridge. Dec. 14.

[1] Stanier, H. M., *Nature*, **165**, 354 (1950).
[2] Machin, K. E., *Nature*, **167**, 889 (1951).
[3] O'Brien, P. A., *Mon. Not. Roy. Astro. Soc.*, **113**, No. 5 (1953).
[4] Ryle, M., Volta Convention Proc., Accademia Nazionale dei Lincei, 276 (1952).
[5] Smerd, S. F., *Aust. J. Sci. Res.*, **3** A, 34 (1950).
[6] Allen, C. W., *Mon. Not. Roy. Astro. Soc.*, **107**, 426 (1947).
[7] Hewish, A. (in preparation).

Television Pick-up Tube for both Light and X-Ray Pictures

Investigations carried out on television camera tubes using the photoconductive effect for converting a light image into an electrical signal have resulted in the development of an experimental tube sensitive to both visible light and to X-rays.

The photoconductive material used in the tube is suitably activated lead oxide, evaporated on a 'Pyrex' glass window. The layer is scanned by a low-velocity electron beam, as described by Weimer, Forgue and Goodrich[1].

The light sensitivity, the peak of which is in the blue part of the spectrum, amounts to about 100–200 microamp. per lumen when an incandescent light source at a colour temperature of 2,600° K. is used. The speed of response is sufficient to make the tube suitable for industrial applications and shows promise for application in television broadcasting.

The relatively good sensitivity to X-rays is the result of the high absorption coefficient of lead oxide for this radiation. A layer of only 5 microns thickness absorbs about 5 per cent of the radiation originating from an X-ray tube operated at 70 kV. d.c., the radiation being filtered by 5 mm. aluminium. The 1·2-mm. thick 'Pyrex' face on which the lead oxide has been applied absorbs about 10 per cent.

The accompanying photographs have been taken from a television monitor tube. Fig. 1 represents a picture produced by the pick-up tube combined with a lens, the object being two identical transistors with a centimetre scale giving an impression of the dimensions. The 'scene' is illuminated with visible light. Fig. 2 shows a picture produced by the pick-up tube when the same transistors were placed in front of the tube face and irradiated by X-rays (X-ray shadow picture). The X-ray source consisted of a Philips's 'Practix' operated with 10 mA. at 72 kV. a.c. and placed at a distance of 70 cm. from the object. In the picture on the monitor tube the statistical noise of the X-ray quanta predominated over the amplifier noise.

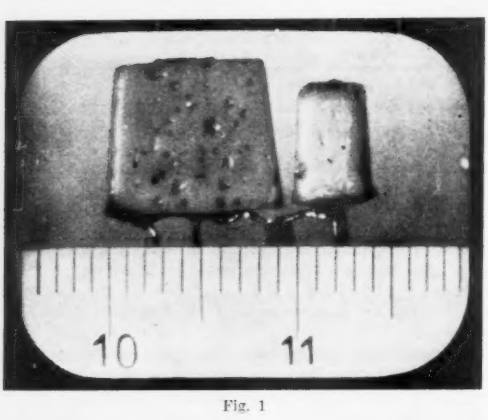


Fig. 1

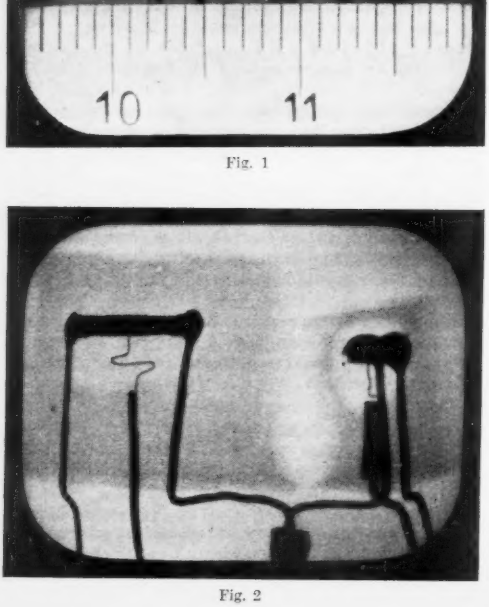


Fig. 2

It is thus possible to make an enlarged X-ray picture of small objects. The pick-up tube has a usable area of 20 mm. diameter, whereas the photograph was taken from a monitor with 35 cm. diagonal.

L. Heijne
P. Schagen
H. Bruining

Philips Research Laboratories,
N.V. Philips Gloeilampenfabrieken,
Eindhoven, Netherlands.
Nov. 30.

[1] *R.C.A. Rev.*, **12**, 306 (1951).

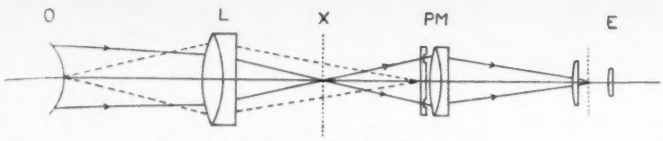
A Phase-Contrast Searcher for the Burch Reflecting Microscope

It is important in the ultra-violet microscopy of biological material to be able to search for and focus the specimen with visible light so that ultra-violet irradiation can be kept to a minimum. As the material examined is normally unstained, little detail can be seen using conventional illumination with the microscope.

To overcome this difficulty, the original Beck-Barnard ultra-violet microscope, produced in 1926, possessed a dark-ground illuminator built around the quartz condenser[1]. The modern counterpart of this instrument, made by Cooke, Troughton and Simms, has a special phase-contrast condenser unit, and in this way an immersion visual phase-contrast objective can be used for preliminary viewing and focusing of the specimen[2]. In the system designed by Walker and Davies[3], focusing is performed in visual phase contrast with the aid of an auxiliary lens and phase plate, introduced behind the objective.

These systems have been used in conjunction with refracting objectives; but it is clear that a similar type of phase-contrast searcher would be of great use with the Burch reflecting microscope. The problem here is somewhat more difficult. By tracing a ray through the optical system, it can be shown that the small mirrors of the condenser and objective can be regarded as conjugate levels. Thus the annulus and phase plate could be ideally located at these mirrors. The introduction of these components to reproducible positions at the small mirrors presents serious mechanical difficulties and therefore was not attempted.

In the illumination system coupled to the Burch microscope, the condenser aperture is controlled by means of an aperture stop imaged at the condenser small mirror; thus the annulus can be located conveniently at this stop. In a similar way, it becomes necessary to image the objective small mirror to a more accessible position. In the system designed by Payne[4], an image of the back focal plane of an



Optical system for phase contrast (not to scale)

objective is formed in an accessible position by means of a concave mirror, the light being deflected to a side tube attached to the microscope. Françon and Nomarski[5] introduced phase contrast in the microscope by means of an eyepiece system, a projection eyepiece forming an image of the back of the objective at the phase plate, which was of strip form. Due to the long optical tube-length (34·5 cm.) of the Burch reflecting microscope, such a lens at the eyepiece level would produce an exceedingly small image of the annulus if the optical system was to be kept to a reasonable length.

To overcome this difficulty, without deflecting the light to a rather inconvenient side-tube, the system shown in the diagram has been adopted. The lens L, situated within the microscope body-tube, images the objective small mirror O at the phase plate P at approximately unit magnification. This lens also causes the main image-forming beam to converge at X. The phase plate is attached to the front surface of a low-power microscope objective M (3 in. focal length), which is focused on the image of the specimen at X. Thus the final image viewed through an eyepiece E appears under phase-contrast illumination. The definition of the image is good, but the curvature of field is rather high, the low-power microscope objective introducing field curvature additional to that of the reflecting objective itself. This has the effect of reducing the diameter of flat field from about 140 μ to 70 μ, a defect which is of little importance for searching purposes.

In the actual system used on the microscope, the lens L is a telescope objective of short focal length and has not been specially computed for the purpose. It produces a well-corrected image of the specimen; but in forming an image of the annulus, the lens is working at conjugates for which the correction is poor. It is therefore advisable for the phase ring to be wide relative to the annulus: chromatic aberration, which produces colour over the whole object field, can be restricted by using green light.

This auxiliary optical system can be introduced into the microscope quite easily. The lens L is swung into the light beam, while the tube containing phase plate, microscope objective and eyepiece fits into the eyepiece tube of the Burch microscope. Set up in this way, the system greatly facilitates searching the specimen, prior to photomicrography and absorption measurements in the ultra-violet.

This work has been supported by grants to the Royal Cancer Hospital and Chester Beatty Research Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service.

R. J. King

Chester Beatty Research Institute,
Royal Cancer Hospital,
London, S.W.3. Dec. 10.

[1] Barnard, J. E., and Welch, F. V., "Practical Photomicrography", 301 (1936).
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Crystal Structure of Glycyl-L-Alanine Hydrobromide

Interest in the crystal structures of simple peptides has increased considerably during recent years on account of progress made in the direct investigation of protein structure. Glycyl-L-alanine hydrobromide has been prepared in these laboratories and examined by X-ray methods. The free dipeptide was prepared by the N-carbobenzoxy method[1] and then converted into the hydrobromide which crystallized readily from aqueous solution.

The crystal data for glycyl-L-alanine hydrobromide are $a = 10{\cdot}69$ A.; $b = 6{\cdot}13$ A.; $c = 7{\cdot}63$ A.; $\beta = 108° 34'$. The density (by flotation) is 1·714 gm./c.c. The number of molecules per unit cell is 2 mol. glycyl-L-alanine + 2 mol. of water of crystallization. Space group, $P2_1$.

The intensities of 154 $h0l$ reflexions were measured visually using copper $K\alpha$ radiation, and the Patterson projection on (010) showed a clearly resolved peak attributable to the Br–Br vector. From the position of the heavy atom the signs of a large proportion of the structure factors could be derived, and from the preliminary Fourier projection the signs of the

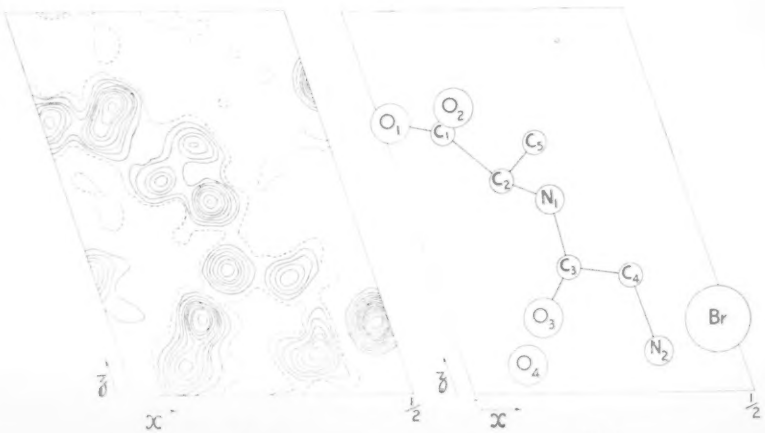

Fig. 1

Fig. 2

remaining terms were obtained. The resulting projection is shown in Fig. 1 and is adequate for placing the atoms in the unit cell, with all the atoms, including the water molecule O_4, being resolved with the exception of C_1 and O_2 (see Fig. 2).

A preliminary examination of the structure using y-co-ordinates derived by assuming probable bond-lengths for the glycyl-L-alanine molecule showed satisfactory hydrogen-bonding, the glycyl-L-alanine and water molecules forming spirals bound together laterally by N—H bonds. A detailed discussion of this aspect will, however, be postponed until the structure has been refined using the hydrochloride, which is isomorphous with the hydrobromide.

T. C. Tranter

Wool Industries Research Association,
Torridon,
Headingley, Leeds 6. Oct. 16.

[1] Bergmann, M., and Zervas, L., *Ber. Dtsch. Chem. Ges.*, **65**, 1192 (1932).

Formulation of the Rate Equation in Chemical Kinetics

Robb[1] has recently pointed out that when the rate-constant for a reaction such as

$$2A + B \rightarrow C$$

is under discussion, it is necessary to state whether the rate referred to is the disappearance of A or of B, since the latter is half as fast as the former.

It is perhaps also worth pointing out that in the academic literature of reaction kinetics, rates are always written as rates of change of concentration in a closed system which is tacitly assumed to be at constant volume; for example:

$$-\frac{\mathrm{d}}{\mathrm{d}t}[A] = -2\frac{\mathrm{d}}{\mathrm{d}t}[B] = k[A]^2[B]. \qquad (1)$$

This equation has only limited application to industrial processes. There are closed reaction systems, for example, in which the volume changes during the reaction, and open systems (such as continuous-flow tank and tubular reactors) in which the concentration is independent of time[2]. The rate-equation is more generally useful when written in a less restricted form; for example:

$$-R_a = -2R_b = \frac{k}{V^2} \cdot a^2 b. \qquad (2)$$

The system to which this equation applies may be open or closed, but has a constant atomic content, and is assumed to be virtually uniform in composition and temperature. At a given instant it has volume V and contains a,b moles of A,B. $-R_a$, $-R_b$ are the rates of destruction of A,B by the reaction. k has the same significance and value as in equation (1).

In a closed system, $R_a = \mathrm{d}a/\mathrm{d}t$; V may be a function of a,b,t. Equation (2) is then to be integrated accordingly. In a flow-system operating at steady state, V, a, b and R_a are constant, the latter being the difference between the rates of inflow and outflow of A. Other variants may also be encountered.

P. V. Danckwerts

Department of Chemical Engineering,
Tennis Court Road, Cambridge.
Dec. 9.

[1] Robb, J. C., *Nature*, **172**, 1055 (1953).
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A Competitive Method of determining Association Constants

The method described by Benesi and Hildebrand[1] for determining the association constants of charge-transfer complexes involves optical measurements of a series of solutions at or near the wave-length of maximum absorption of the complex. A simple method for determining such constants which avoids these conditions has been devised.

Consider the two interactions:

$$A + B' \rightleftharpoons AB' \quad \text{and} \quad A + B'' \rightleftharpoons AB'',$$

involving two Lewis bases B' and B'' and a Lewis acid A (or vice versa). An equilibrium constant K may be defined as:

$$K = \frac{[AB]}{([A]-[AB])\,([B]-[AB])}, \qquad (1)$$

where $[A]$ and $[B]$ are the initial concentrations of A and B. For simplicity, let $[B']=[B'']=[B]$, say, then if $[B] \gg [A]$:

$$K' = \frac{[AB']}{[B]\,([A]-[AB']-[AB''])} \qquad (2)$$

and

$$K'' = \frac{[AB'']}{[B]\,([A]-[AB']-[AB''])}. \qquad (3)$$

Eliminating $[AB'']$ from equations (2) and (3):

$$[AB'] = \frac{K'[A]\,[B]}{1 + K'[B] + K''[B]}. \qquad (4)$$

A wave-length is selected at which the species A, B', B'' and AB'' have negligible absorptions, but at which AB' absorbs (preferably at or near the maximum of the charge-transfer spectrum of this species). If the extinction coefficient of the species AB' at this wave-length is ε, then the optical density of a solution at this wave-length will be $D = \varepsilon[AB']$.

The optical densities of two solutions, one containing A and B' at concentrations $[A]$ and $[B]$, the other containing A, B' and B'' at concentrations $[A]$, $[B]$ and $[B]$, are measured at this wave-length. If D_1 and D_2 are the two optical density readings so obtained, then applying equation (4):

$$\frac{D_2}{D_1} = \frac{1 + K'[B]}{1 + K'[B] + K''[B]}, \qquad (5)$$

or

$$K'' = \frac{D_1 - D_2}{D_2}\left(K' + \frac{1}{[B]}\right). \qquad (6)$$

Knowing K', K'' may be determined.

Applying the method to the complex of N-*n*-butylaniline and *s*-trinitrobenzene by measuring the competition of the former with N-N-N′-N′-tetramethyl *p*-phenylenediamine in *cyclo*hexane, the following results were obtained:

$$[B] = 0{\cdot}118\,M\,; \quad [A] \simeq 10^{-4}\,M\,;$$

$D_1 = 0{\cdot}320$ cm.$^{-1}$ and $D_2 = 0{\cdot}255$ cm.$^{-1}$ at 650 mμ.

Using a value of $K = 20{\cdot}4$ litres/mole for the association constant of N-N-N′-N′-tetramethyl *p*-phenylenediamine with *s*-trinitrobenzene in *cyclo*hexane (obtained by the method of Benesi and Hildebrand), a value of the association constant of N-*n*-butylaniline with *s*-trinitrobenzene in *cyclo*hexane of 7·4 litres/mole is obtained. The value obtained by the method of Benesi and Hildebrand is 8·2 litres/mole.

R. Foster

Dyson Perrins Laboratory,
South Parks Road, Oxford. Oct. 12.

[1] Benesi and Hildebrand, *J. Amer. Chem. Soc.*, **71**, 2703 (1949).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 1

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. W. R. Howard: Presidential Address.

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (in the Chemical Society's Rooms, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. J. W. Barrett: "Production and Development of Chemicals for the Rubber Industry".

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (joint meeting with the ALEMBIC CLUB, in the Physical Chemical Laboratory, Oxford), at 8.15 p.m.—Mr. A. R. Powell, F.R.S.: "The Platinum Metals".

Tuesday, February 2

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. M. Mary Douglas: "Primitive Medicine among the Lele of the Belgian Congo".*

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. F. Richardson and Mr. W. N. Zaki: "Sedimentation and Fluidization".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 6 p.m.—Prof. H. Munro Fox, F.R.S.: "Colour in Animals". (Further Lectures on February 9, 16 and 23.)

Wednesday, February 3

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. J. G. Capewell: "The Post-Silurian, Pre-Marine Carboniferous Sedimentary Rocks of the Eastern Side of the English Lake District"; Dr. F. W. Anderson and Dr. V. Wilson: "The Occurrence of Algal Beds in British Paleozoic and Jurassic Rocks".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 6.45 p.m.—Internal Combustion Engine Group Discussion: "The Extent to which the Gas Turbine May Supplant or Supplement the Piston Engine in the Next Ten or Twenty Years".

Thursday, February 4

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. J. Maynard Smith: "Mendel, Michurian and Hybrid Vigour".*

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m. and 7.30 p.m.—Symposium on "Kinetics and Mechanism of Inorganic Reactions in Solution. A Survey of Recent Work".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. J. C. Bevington, Mr. G. M. Guzman, and Prof. H. W. Melville, F.R.S.: "Self-branching in the Polymerization of Styrene and of Vinyl Acetate"; Mr. P. Alexander, Mr. A. Charlesby, and Mr. M. Ross: "The Degradation of Solid Polymethylmethacrylate by Ionizing Radiation".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. R. Melville: "Plant Hunting Across Australia, 1952–1953".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. G. Dawson, Mr. L. L. Hall, Mr. K. G. Hodgson, Mr. R. A. Meers, and Mr. J. H. H. Merriman: "The Manchester–Kirk o' Shotts Television Radio Relay System".

ROYAL METEOROLOGICAL SOCIETY (in the Conference Hall, County Hall, Westminster Bridge, London, S.E.1), at 5.30 p.m.—Mr. J. S. Sawyer: "Weather Forecasting".*

UNIVERSITY OF LONDON (at the School of Pharmacy, 17 Bloomsbury Square, London, W.C.1), at 5.30 p.m.—Prof. J. H. Gaddum, F.R.S.: "Discoveries in Pharmacology".* (Further Lecture on February 5.)

UNIVERSITY OF LONDON (at Senate House, London, W.C.1), at 5.30 p.m.—Air Marshal Sir Harold Whittingham: "Medical Science and Problems of Flying".* (Further Lecture on February 11.)

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. F. Bergel: "Some Chemical Aspects of Abnormal Growth".* (Further Lecture on February 9.)

INSTITUTE OF METALS, LONDON LOCAL SECTION (at 4 Grosvenor Gardens, London, S.W.1), at 6.30 p.m.—Mr. R. W. Douglas: "Germanium and Silicon".

INSTITUTE OF WELDING, NORTH LONDON BRANCH (at Manson House, Portland Place, London, W.1), at 7 p.m.—Dr. R. Week: "Avoiding Fatigue in Welded Structures".*

Friday, February 5

SOCIETY OF COSMETIC CHEMISTS OF GREAT BRITAIN (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 7 p.m.—Prof. W. D. Wright: "Colour and Colour Vision".

POLISH CULTURAL INSTITUTE (at 81 Portland Place, London, W.1), at 8 p.m.—Dr. M. J. Seaton: "The Copernican Controversy and its Significance for Modern Science".*

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. M. Postan: "Medieval Science and Technology".

Saturday, February 6

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. M. Freedman: "Death and Marriage Among Chinese in Singapore".*

BRITISH INTERPLANETARY SOCIETY (in the York Hall, Caxton Hall, Westminster, London, S.W.1), at 6 p.m.—Mr. K. W. Gatland: "Progress Towards Astronautics".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER IN CHEMISTRY, at the University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (February 6).

EXPERIMENTAL OFFICER (Physicist or Metallurgist) (with at least H.S.C. (science), or equivalent, but degree in metallurgy or physics may be an advantage), for work on X-ray diffraction IN THE METALLURGY DIVISION—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Berks, quoting 2/103/4 (February 6).

HEAD (graduate in science, engineering or mathematics, and with suitable experience in the textile industry) OF THE TEXTILE DEPARTMENT, Bolton Technical College—Chief Education Officer, Education Offices, Nelson Square, Bolton (February 6).

HEAD (with honours degree in chemistry, and textile experience, preferably in the hosiery trade) OF THE CHEMISTRY DEPARTMENT—The Secretary, Hosiery and Allied Trades Research Association, 4 First Avenue, Sherwood Rise, Nottingham (February 6).

PHYSICISTS, Scientific Officer grade (with first- or second-class honours degree, or equivalent), or Experimental Officer grade (with H.S.C. (science), or equivalent), in Ministry of Supply Research and Development Establishments, to apply their knowledge to problems from many fields, including aerodynamics and aircraft structures, aircraft instruments, armaments, electronic circuits, radio and radar—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A1/54A (February 6).

SENIOR LECTURER (preferably with knowledge of applied chemistry) IN INORGANIC CHEMISTRY—The Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham (February 6).

LECTURER (graduate in chemical engineering, or graduate in chemistry, with postgraduate training and/or experience in chemical engineering) IN CHEMICAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (February 8).

FIRST ASSISTANT STATION CHEMIST (preferably with university degree or A.R.I.C.), at Barton Generating Station, Manchester—The Establishments Officer, British Electricity House, 825 Wilmslow Road, Manchester 20, quoting "Vacancy No. 6-54" (February 13).

SCIENTISTS, Grade II or III (with first- or second-class honours degree, or equivalent, in engineering, mathematics or physics, and some experience in field or laboratory research) IN THE FIELD INVESTIGATION GROUP, to carry out field work at collieries—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/729 (February 13).

ANALYTICAL CHEMIST IN THE DEPARTMENT OF AGRICULTURAL CHEMISTRY—The Registrar, Wye College, near Ashford, Kent (February 15).

CHAIR OF BOTANY—The Registrar, University College, Singleton Park, Swansea (February 15).

MAY AND BAKER RESEARCH FELLOW (with qualifications in plant pathology, and some postgraduate research experience) to undertake research work under the direction of the Professor of Agricultural Chemistry, on fungicides and systemic fungicides (including field trials)—The Registrar, Wye College, near Ashford, Kent (February 15).

ASSISTANT LECTURER IN APPLIED MATHEMATICS—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (February 20).

CHAIR OF ELECTRICAL ENGINEERING—The Registrar, The University, Nottingham (February 20).

LECTURER IN BACTERIOLOGY, and an ASSISTANT LECTURER IN CHEMISTRY—The Registrar, Trinity College, Dublin (February 20).

PRINCIPAL SCIENTIFIC OFFICER (with an honours degree in science or civil engineering, and a knowledge of applied mathematics and physics, and preferably with experience in the application of soil mechanics to civil engineering design and construction) in the Air Ministry, for work on soil mechanics at Church Lawford, Warwickshire—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting E.41/54A (February 20).

ASSISTANT NUTRITIONIST (non-medical) (with B.Sc. in biological sciences, and some teaching and research experience), for evaluating dietaries, analysing field data, abstracting papers, preparing reports and assisting in teaching tropical nutrition and dietetics—The Director, Applied Nutrition Unit, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1 (February 22).

READER IN MORBID ANATOMY, tenable at London Hospital Medical College—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 22).

HEAD (with good honours degree, and teaching experience) OF THE MATHEMATICAL DEPARTMENT—The Registrar, The Royal Belfast Academical Institution, Belfast (February 28).

LECTURER IN PSYCHOLOGY at New England University College, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Armidale, March 1).

ROBERT BLAIR FELLOWSHIP tenable for one year of advanced study or research abroad in Applied Science or Technology—The Education Officer (EO/H1/2), County Hall, London, S.E.1 (March 1).

LECTURER IN THE DEPARTMENT OF CHEMISTRY, Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Wellington, March 5).

CHAIR OF GEOGRAPHY—The Registrar, University College of Leicester, Leicester (March 6).

READER (with high academic qualifications, and research experience in theoretical physics, preferably in quantum theory) IN THEORETICAL PHYSICS, at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, March 22).

TURNER AND NEWALL RESEARCH FELLOWSHIP IN ENGINEERING, INORGANIC CHEMISTRY or PHYSICS, or other allied science—The Registrar, The University, Leeds 2 (April 21).

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BRITISH RUBBER PRODUCERS' RESEARCH FELLOW (with a good honours degree in engineering or physics, and industrial or research experience) for research into the mechanical properties of rubber—The Registrar, The University, Nottingham.

ENGINEERS, PHYSICISTS, PHYSICAL CHEMISTS and METALLURGISTS (Senior Scientific Officer and Scientific Officer grade) (with an appropriate first- or second-class honours degree or equivalent high professional attainments) in Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth, Weymouth and Gloucestershire areas, and Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.246/52A/T2.

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LECTURER (with a good honours degree in applied or pure science, and research and industrial experience) IN MECHANICAL ENGINEERING—The Registrar, The University, Nottingham.

MATHEMATICS MASTER (with high honours degree)—The Head Master, Lancing College, Shoreham-by-Sea, Sussex.

METALLURGIST (with a degree in metallurgy or equivalent qualification, and preferably with previous industrial experience) for work entailing the application of research results in industrial practice—The Secretary, British Non-ferrous Metals Research Association, 80–91 Euston Street, London, N.W.1.

MINING GEOLOGIST (with B.Sc. degree with honours in mining geology) in the Colonial Geological Survey Service, Sierra Leone, for duties which include search for new mineral deposits, mapping, petrology and mineralogy of known mineral deposits, geological mapping, geophysical prospecting by resistivity and magnetometry—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.105/15/02.

PHYSICIST (with first- or second-class honours degree in an appropriate scientific subject, of a United Kingdom or Commonwealth University, or an equivalent qualification) IN THE COLONIAL INSECTICIDES RESEARCH UNIT, at the Ministry of Supply Chemical Defence Experimental Establishment, Porton, near Salisbury, to undertake research work in connexion with the application of chemical formulations for the control of pests of public health and agricultural importance—The Under-Secretary of State, Research Department (S.610), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

PHYSICISTS (with good honours degree, and some experience or training in research, not necessarily in textile research), for work on textile problems—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, near Manchester.

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